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PESTICIDES PROGRAMS

U. S. Department of Agriculture



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PESTICIDES PROGRAMS

U. S. Department of Agriculture

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## SUMMARY OF ACTIONS ON PESTICIDE PROGRAMS

General1. Pesticides Coordination

Shortly after the Congress appropriated \$250,000 for pesticides coordination activities, this Department established a position of Pesticides Coordinator in the Office of the Secretary. This position was filled by an eminent scientist who had had considerable work experience in pest research programs. Over the past year and a half, the Pesticides Coordinator launched several programs designed to strengthen intra- and inter-departmental coordination in the pesticides area. A listing of these programs was provided in the summary statement on pest programs which was inserted in Part I of the hearings before this Committee for Fiscal Year 1966.

Since the Pesticide Coordinator's experience and his professional stature had been acquired in the area of pest research and his primary interests and concerns were in that area, he requested permission to return to research activities. Because of his sincere interest and capability in this field, his request was granted. In order to provide for continuing activity in the coordination area, a Department Pesticides Committee has been established. This Committee has assumed responsibility for reviewing all USDA pest control programs and also serves as the coordinating mechanism with other Federal departments concerned with pest control.

Membership on the Department's Pesticides Committee includes those officials who represent USDA on the Federal Committee on Pest Control. In this way, the Department's Pesticide Programs are coordinated internally and are planned in close cooperation with other Federal agencies concerned. The use of a committee consisting of program officials concerned with pest control programs also has the advantage of involving the operating level fully in the coordination process.

2. Federal Committee on Pest Control

During the last year the Department has continued working closely with the Federal Committee on Pest Control. This group has provided cooperative action by USDA, Department of Interior, HEW, and DOD in Federal pest control activities. The primary activities of the Committee over the last year have involved the development of a monitoring plan which is discussed in more detail below, the coordination of information activities concerning pest control programs, and the review of the major Federal pest control programs to assure their safety and effectiveness.





## Registration

1. Close working relationships have been maintained with officials responsible for enforcing state laws regulating registration, labeling, and sale of pesticides. Liaison membership is maintained on the Executive Committee of the Association of American Pesticide Control Officials and the Department has advisory members on the Regulations Committee, Toxicology and Antidote Committee, Terms Committee, and Methods Clearing House Committee. The Department also sponsors an annual spring meeting with this Association to remain cognizant of the policies and views of the various state regulatory officials and to keep them properly informed on the latest actions under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to assure uniformity between Federal and State enforcement policies. A continuous exchange of information with state regulatory officials is maintained.
2. Department scientists have taken an active part in the recently established Experiment Station Committee on Pesticides regarding the establishment of tolerances on minor crops. Continuing exchange of information with the ESCOP Committee representative has been maintained.
3. Regulations for the enforcement of the FIFRA were amended on August 29, 1964, to prohibit the use of unwarranted safety claims on labeling and to require that the USDA registration number appear on the label of every economic poison registered under the Act, as authorized by P.L. 88-305. The effective date for this amendment and certain provisions amended on May 27, 1964, has been extended to October 1, 1966, with respect to products registered prior to the initial effective date and for which no changes in labeling or formula have been made since that time. This extension was granted in order to permit an orderly change in labeling of the approximately 60,000 pesticide products currently registered.
4. An amendment to the interpretative regulations regarding the use of thallium sulfate in the household was published in the Federal Register on July 2, 1965. This amendment restricts registration of thallium products intended for household use to those which bear the statement "For Use By Government Agencies Only" and a warning against use by the general public.

This action was based on accident records which revealed that thallium products cannot be labeled to provide adequate protection when used in the household by the general public.

5. The agreement between this Department and the Departments of Health, Education, and Welfare and Interior for the purpose of coordinating activities of the three Departments pertaining to pesticides has been implemented. The Department of Agriculture





is presently referring all applications for registration to the Department of Health, Education, and Welfare and selected applications based on the nature of the use to the Department of the Interior on a weekly basis. This referral is to give the interested agencies an opportunity to offer comments and recommendations on the proposed uses.

6. The committee established by the National Academy of Sciences to study the problem of zero tolerances and no-residue registrations submitted its report in June of 1965. The report contained several recommendations for changes in procedures. This report has been thoroughly studied and several conferences were held with members of the FDA. A joint position statement is presently being studied which will, when adopted, largely implement the principles set forth in the recommendations insofar as is possible under existing laws.
7. A review group was appointed to study the functions of the Pesticides Regulation Division for the purpose of recommending changes which might result in increased efficiency. As a result of this group's report, a considerable expansion in both the registration and enforcement activities is contemplated. Increased enforcement activities are required to insure that products shipped in interstate commerce meet the requirements of the law.

#### Information Activities

1. The first two of a planned series of Fact Sheets on Pest Control were prepared and issued. These publications are: "The War That Never Ends--Facts About Pest Control" and "Your Home and Safe Use of Pesticides." To date distribution has been 20,000 and 60,000 copies, respectively.
2. Approximately 70 USDA publications have been revised to update pesticide information in conformity with the Department's pest control policy.
3. The Advertising Council in its May-June (1965) Radio-TV Bulletin announced its renewed endorsement of the USDA pesticide safety program. Broadcasters across the nation were advised as to the availability of records, films, tapes, and other materials from USDA. The response has been good.
4. Production of six films is underway as a means of translating the Department's pesticide policy into dramatic terms appealing to the consuming public. The first film, described below, has been completed, and production work is underway on a 28-minute color movie. Four five minute films designed primarily for television viewing will be made from the two larger movies.

"Pests or Plenty?", 13-minute, consumer-oriented color film, first production in planned package. The story of the vital role pest control plays in assuring the nation's families of





an abundant supply of quality, wholesome food products. Emphasizes Department's concern for safety and research efforts. National promotion and distribution has begun, using promotional flyer with 175 prints available for use by television stations, state libraries, school systems, civic organizations, etc. In showings so far, film has been well received. The film recently won an award at the Fourth International Agricultural Film Competition in Berlin.

"Impact of Pesticides," 11-minute movie designed mainly for television use, covers the pilot pesticides monitoring program in the Mississippi Delta. It has been seen by various organizations such as the wildlife conservationist Isaac Walton League and other interested state and local groups.

5. A new USDA pest control exhibit had its premier at the recent Public Symposium on the Scientific Aspects of Pest Control held in Washington under the auspices of the National Academy of Sciences. The exhibit, which will be used at fairs, conferences, etc., features the twin themes of the importance of pesticides to modern living and the need for safe, proper use.
6. The directors of information for Agriculture, Interior, and HEW recently arranged for the exchange and clearance of news releases relating to pesticides. This agreement is designed to generally improve communication and coordination among the three departments. Much remains to be done, however, before fully satisfactory working arrangements are achieved in this area.
7. Release of information to news media on the Department's pesticides-pest control activities was greatly expanded both in frequency and scope during the past year. More than 30 releases relating specifically to pesticides were issued together with dozens of news stories on pest research and control projects. The scope of the individual news releases was broadened to give a more complete picture of the Department's objectives and accomplishments in the pest control field.
8. An interdepartmental bulletin describing the purposes and functions of the Federal Committee on Pest Control was issued recently through USDA facilities. The Department assisted in editorial preparation through the FCPC Information Subcommittee, and assumed all production costs. The bulletin was distributed initially at the Public Symposium on the Scientific Aspects of Pest Control.

#### Control Programs

1. For the second year in succession, the Mexican fruit fly on the Mexican-California border has been successfully controlled by the release of sterile males. This work is being carried out in the vicinity of Tijuana and Baja California, Mexico. The application of pesticides has not been required to prevent flies from migrating into California.



2. Again in 1965, malathion was used as a substitute for persistent chlorinated hydrocarbons. Malathion has been successfully used in low volume spraying for the control of grasshopper, beet leafhopper, cereal leaf beetle, and boll weevil. Altogether low volume spraying with malathion has been used on about seven million acres. Low volume spraying with malathion saves time and money and minimizes residue hazards.
3. Malathion was used on the Presidio-Ojinaga area on the Texas-Mexico border this year as a part of a two-year program to determine if boll weevils could be eradicated. The success of the work was demonstrated by increased number of bales of cotton ginned.
4. Carbaryl was used again in 1965 in place of DDT to control gypsy moth on 56,000 acres in New York, New Jersey, and Pennsylvania.
5. With the increased emphasis on uniform aerial application, guidance for aircraft during each swath run has been stressed. Several methods have been used in recent years. However, for satisfactory program accomplishment, each method has been costly in manpower, vehicles, and guidance equipment. It is now planned to test a radio guidance system. If it performs as anticipated, guidance will be more accurate and costs will be reduced through savings in manpower, vehicles, and equipment.
6. The Forest Service reduced sharply reliance on chlorinated hydrocarbons as a result of progress made in screening and testing effective non-persistent pesticides. Use of DDT in forest spraying was cut in half in the past three years. It will be further reduced in 1966.
7. In forest spraying operations, helicopters are being used exclusively in and near all sensitive areas, such as major streams, lakes, meadows, and pastures, to minimize drift.
8. Forest spraying operations are being carefully monitored to determine the impact of the pesticides used on game, fish, livestock, beneficial insects, and to check for contamination in water, soil, and plants. Monitoring work is carried out in cooperation with Federal and State fish and game groups, and with Federal and State water sanitation, public health groups, and regulatory agencies.

#### Monitoring

Impact on Environment of Agricultural Pesticide Use. The agricultural pesticide monitoring program, which was initiated in the Mississippi Delta in May 1964 to determine effects of agricultural pesticide use, was continued and expanded during 1965. Intensive sampling of soil,





sediment, water, crops, fish, and wildlife was carried out at Stuttgart, Arkansas; Greenville and Utica, Mississippi; Mobile, Alabama; Yuma, Arizona; and Grand Forks, North Dakota. Preliminary monitoring results on soils, water, and sediment at the Mississippi Delta stations show no progressive buildup of any great magnitude of organic pesticides in these media. Indications were found of a past buildup of arsenic, however. The accumulation of arsenic, presumably, was from use of calcium arsenate on cotton prior to the advent of the chlorinated hydrocarbon insecticides. A report on the findings in soil, water, and sediment is being prepared for distribution to agencies having interest in pesticide use considerations. In addition to the large-scale farm studies, special studies on the fate of pesticides in soils was initiated in 15 locations of high pesticide use across the country. These locations include fruits, vegetables, peanuts, corn, alfalfa, sugar beets, and potatoes. As a part of the National Pesticides Monitoring Program, sponsored by the Federal Committee on Pest Control, 32 additional sites were selected for the determination of residue levels in soils in areas where light amounts of pesticides or no pesticides have been applied. This part of the program is regarded as a pilot-scale study. Results from the soils work in high and low use areas will indicate the need for additional monitoring activities or specific research projects. A total of 5,100 samples was analyzed at the Central Monitoring Laboratory at Gulfport, Mississippi, during the year. The analytical work was expanded to include herbicides, fungicides, and defoliants as well as insecticides.

Monitoring the Effects of Cooperative Treatment Programs on the Environment. Results of monitoring programs initiated in 1964 on impact of large-scale programs on the environment were evaluated and distributed during 1965. A large part of these monitoring efforts were in cooperation with other Federal and State agencies. The major conclusions derived from the studies are listed below. The Texas Parks and Wildlife Commission and the Texas Technological College cooperated in checking the effects of low volume malathion treatments against boll weevils in the Texas High Plains. Findings showed that fish and wildlife suffered no injury and populations of beneficial insects were depressed but apparently not significantly. Studies by Michigan State Department of Conservation revealed that the low volume malathion treatments against cereal leaf beetle had no harmful effect on wildlife. Investigations carried out by U. S. Fish and Wildlife Service showed that the direct effects on wildlife appeared to be slight when low volume malathion was used against grasshoppers. Blood cholinesterase levels were apparently lowered in both wild and caged turkeys but the effects were not believed significant. Small animals were apparently unaffected. The Michigan State University cooperated in monitoring the effects of dieldrin against Japanese beetles in the Battle Creek, Michigan, area. Dieldrin residues were present in soil samples but not in water, and residues were at low levels or were absent from sediment samples collected in stream beds or ponds.





Monitoring of the burrowing nematode program in Florida showed that bromine residues from ethylene dibromide treatment were well below accepted tolerance levels in both grapefruit and oranges adjacent to the treatment barriers. Monitoring of 2, 4-D and trifluralin in connection with the witchweed program in North Carolina and South Carolina showed 2, 4-D residues at low levels on corn. No harmful effects on fish were noted. The gypsy moth program was monitored in 1964 in New Jersey and Pennsylvania and it was concluded that the treatment had no harmful effects on wildlife. The 1965 studies in Pennsylvania were designed to determine the effects of carbaryl on fish and the macroinvertebrates inhabiting the streams within the treatment area. Additional programs monitored in 1965 were grasshopper control in Wyoming and boll weevil in the Texas High Plains. Reports will be made available on these projects as soon as the studies are completed. Special technical assistance was arranged on a contractual basis with colleges and universities for several of these studies.





The major emphasis in the research and education programs continues to be directed toward the development and use of safer and more specific pest control measures. A summary of major accomplishments under each of the targets of the Department's pesticide program follows:

Target I - To control plant pests and diseases and animal parasites by non-pesticidal methods:

Field Crops

- a. Some diseases and nematodes may be controlled in part or in whole by cultural practices such as cultivation, irrigation, row-spacing, etc.
- b. Biological agents have shown promise in controlling aquatic weeds.
- c. Resistance to corn stunt and maize dwarf mosaic has been developed in four corn inbred lines.
- d. Resistance to stem rust has been successfully transferred from rye to wheat.
- e. Resistance to cereal leaf beetle has been located in some varieties of wheat, oats, and barley.
- f. Outstanding progress has been made in breeding cotton resistant to verticillium wilt.
- g. Two safflower varieties resistant to rust and phytophthora root rot, breeding lines of castor beans resistant to capsule mold and drop and sesame resistant to bacterial leafspot have been developed.

Horticultural Crops

- a. Nineteen varieties of citrus have been indexed for viruses, thereby providing sources of virus-free budwood.
- b. Three citrus rootstocks resistant to the burrowing nematode and four grape rootstocks resistant to nematodes have been released.
- c. New introductions include two strawberry varieties with multiple disease resistance, green snap beans resistant to curly top, and two potato varieties resistant to leafroll virus and two soilborne diseases.
- d. Nearing release are tomatoes resistant to tobacco mosaic, and curly top, potatoes resistant to late blight, sweetcorn resistant to corn earworm, onions resistant to soilborne diseases and insects; lima beans resistant to new races of mildew and mimosa trees resistant to nematodes and root diseases.





### Animals

- a. Progress has been made in the protection of turkeys from blackhead by the introduction of laboratory-reared parasites.
- b. Research has demonstrated for the first time under controlled experimental conditions that a species of livestock can be made resistant to one of its parasitic intestinal worms.
- c. Control of the breeding sites of face flies reduces the need for the use of chemicals on the animals.

### Forest

- a. Spore transport routes of blister rust during the night hours have been determined.
- b. Isolation and identity of fungi associated with sweet gum has been accomplished .
- c. Long-term cooperative tests have yielded hybrid and Chinese chestnut trees with promise of chestnut blight resistance .
- d. A hybrid Jeffery pine has been developed that is insect resistant .
- e. An explanation of the mechanism of action of BT on insects has been found .
- f. Control of the hemlock looper by an integrated approach - biological and chemical - is compatible .
- g. Host selection by smaller European bark beetle was traced to a feeding stimulant present in elm bark .
- h. Control of the balsam wooly aphid in the Southwest by the predator Aphidecta oblitterata from Europe is most promising .
- i. Ambrosia beetle damage to green stored hardwood logs can be prevented by a continuous water spray .

### Equipment and/or Methods

- a. The use of light traps using ultraviolet and green light provide a very strong attractant for stored-product insects.





- b. Gamma irradiation stopped the development of Indian meal moth, Angoumois grain moth, black carpet beetle, and Trogoderma glabrum when exposed in egg or larval stages.
- c. A new fluorescent lamp radiating energy in the blue-green region of the visible spectrum has been developed and successfully lures boll weevils into light traps.
- d. An improved model flail machine was built which picked up 84 percent of the fallen squares and destroyed 96 percent of the immature weevils within the squares.

#### Entomological (general)

- a. Bacillus thuringiensis has continued to provide control of the European corn borer.
- b. A technique has been developed to rear aphid parasites for subsequent release in alfalfa fields providing a high ratio of parasites to aphids.
- c. Mexican fruit flies along the Mexican-California border continue to be controlled by release of chemically sterilized Mexican fruit flies replacing the need for chemical spray.
- d. A bait-chemosterilant experiment was successful in control of fruit flies.
- e. The relationship between the increase in "yellows" of wild host plants and decline in production of sugarbeets has been established.
- f. The sex attractant of virgin female pink bollworm has been identified and a 16-step synthesis proposed.
- g. A large scale test area on St. Croix Island will serve as the proving ground for "area control" of several insects by new approaches.
- h. A relationship between the physiological changes in corn silk and the survival of the corn earworm has been established.



- i. Bracon mellitor, a parasite of the boll weevil has been successfully reared in the laboratory. Females of the parasite released in a cotton field parasitized about one-half of the native weevil population.
- j. Control of the boll weevil has been effected with a granular formulation of the micro-sporidian Mattesia grandis.





Target II--To gain knowledge of the biology, ecology, physiology, pathology, metabolism, and nutrition of insects, plants and animals in order to develop safe means of control:

#### Field crops

- a) Phosphate insecticides delay fruiting and maturity in cotton.
- b) Barley yellow dwarf virus has been purified and identified.
- c) Cereal rust spores carried by early spring rains are responsible to a great extent in development of epidemics.
- d) Corn stunt virus has been found to be confined to the South and only transmitted by leafhoppers. The host range is limited. Dwarf mosaic virus occurs in both the Southern States and the Corn Belt and can be transmitted mechanically and by aphids to a large number of hosts.

#### Horticultural crops

- a) Improved control methods have been developed for insects attacking grapes in vineyards and infesting wineries.
- b) Strawberries and grapes can be freed from viruses by methods developed in basic research programs.
- c) A promising indicator plant has been identified in relation to the stubborn disease of citrus.

#### Animals

- a) Production of parasite-free lambs is expected to make possible experiments leading to the development of measures for biological control of parasites.
- b) The discovery of malformed male specimens of the common stomach worm of sheep following use of therapeutic doses of phenothiazine could make possible the use of parasites as a sensitive criterion to teratogenic effects.
- c) The growth of 8 species of nematodes through one or all of their parasitic stages has been accomplished and will open new areas of basic research.
- d) Work on basic metabolism, fate, and role of agricultural chemicals led to the discovery that 42 pesticides were not being utilized by the ruminal bacteria and the chemicals were not inhibiting the metabolism of the bacteria.





## Forest

- a) Nitrogen in nitrate form inhibits a serious root rot of Douglas-Fir.
- b) Certain acetates and bicarbamates inhibit the germination of fusiform rust spores.
- c) Soil fumigation appears promising for the elimination of root-suppressing fungi that attack Monterey pine seedlings.
- d) The susceptibility of eastern white pine to chlorotic dwarf disease is genetically controlled, the causal agent apparently acting directly upon the foliage.
- e) An effective repellant to deter rabbits from planted seedlings has been developed.
- f) An olfactory mating response has been established for the European pine shoot moth. The duration of moth flight has been determined.
- g) Low level population of the gypsy moth may be controlled by maintaining forest conditions favorable to predators, such as small mammals, birds and insect parasites, or by use of genetically altered male moths.

## Entomological (general)

- a) Investigations of a number of aspects of the action of light on insects indicate that the manipulation of the photoperiod may offer means of control.
- b) Additional information on mechanisms of resistance of the house fly and mosquito to chlorinated hydrocarbons, organophosphorus and carbamate compounds has been obtained.
- c) Boll weevil larvae have been reared on a diet containing a red dye and resulted in pink colored adults enabling the moths to be traced and their distribution and population studied.
- d) The metabolism of fatty acids by the boll weevil has been established as well as the relationship between certain types of pesticides and the fatty acid content of the boll weevil.



Target III To develop less persistent conventional pesticides, improved methods of application, and detection methods of determining residues in the processing and marketing of agricultural commodities.

#### Field Crops

- a. Development of better methods of application of fungicides to cotton has reduced losses from seedling disease.
- b. Selective application of some of the newer systemic pesticides to stems of cotton controlled various pests and reduced amount of pesticide required per acre with little or no soil contamination.

#### Horticultural Crops

- a. Use of combination treatments for control of multiple pest problems is equal to or superior to control obtained when each pesticide is applied separately.
- b. Postplanting nematocide treatments in irrigation water gave superior control of nematodes and increased production of navel oranges and reduced air pollution almost to zero.
- c. A new fungicide gave superior control of pecan scab with fewer applications than currently recommended.

#### Animals

- a. Bovine venereal trichomonias was controlled by a synthetic compound in feed for 5 days or a single intravenous injection. Residual problems are minimal.
- b. Large intestinal roundworms of pigeons and gapeworms of turkeys were successfully controlled by feeding medicated mash.

#### Forest

- a. The erratic control of white pine blister rust with cycloheximide has been found to be due to moisture.
- b. Southern cone rust in slash pine seed production can be controlled with applications of ferbam at 5-day intervals during emergence to pollination.
- c. The accumulation of DDD in certain lake waters following applications of DDT may be explained by the fact that DDT can be converted to DDD by reduced porphyrins present in plant and animal systems.





- d. Control of white pine cone beetle has been obtained by injection of a systemic insecticide into the trunk of the tree.

#### Equipment and/or Methods

- a. Improved formulations of malathion have been developed for protection of inshell almonds and walnuts.
- b. Several potential pesticides indicate they are specific for certain species, leave no residues on grain, or are of very low mammalian toxicity.
- c. Several benzyl quarternary ammonium compounds and a number of poly-substituted nitrogen compounds have been found to be promising mothproofers and with further development will increase their safety for humans.
- d. A multiwall paper bag with an insect-tight closure and approved synergized pyrethrin outer treatment will protect flour and cornmeal against insect infestation, resulting in the savings of millions of dollars.
- e. Dichlorvos, an effective pesticide, applied daily for 5-1/2 months to stored tobacco results in only a trace amount of residue on the tobacco.
- f. A reduction of 30 - 40 percent in the amount of insecticide used for control of barn flies on cattle has been obtained by the use of an automatic cattle sprayer.
- g. Improved malathion formulations applied by low-volume techniques, deposited heavier residues and permitted lower original dosages per acre or less frequent applications.
- h. Several new chemicals, with low mammalian toxicity, have been proven as residual and space sprays in control of house flies, stable flies and mosquitoes.
- i. An effective combination of stabilizers has been found that can be used to prevent oxidation of pyrethrins when applied by airplane.



Target IV. To determine the toxicological and pathological effects of pesticides and other agricultural chemicals in livestock; to determine the fate and effect of residues in soils, crops, and farmstead water supplies; and determine the effects of trace levels of pesticides occurring in our food and feed supplies.

#### Field Crops

- a. Studies of analogs of established herbicides have resulted in more selective materials, which, properly applied, have given control of weeds in new seedings of perennial forage grasses and permitted certification of seed crops upon weed elimination.
- b. Control of fruit size, correction of alternate bearing and enhancement of storage qualities of apples and pears resulted from proper application of growth retardant .
- c. Relationship between chemical structure of certain herbicides and their breakdown by soil micro-organisms has been established.

#### Animals

- a. Purified dimethoate added to diet of beef cattle did not impair their health as did technical grade dimethoate.
- b. Ferrous Furmarate added to the diet of mink prevented cotton pelt condition and was beneficial to production.
- c. Steatitis in mink was prevented with BHT added to their feed.
- d. Vitamin E added to diet of rabbits increased the number weaned per doe and reduced the mortality of young rabbits.

#### Equipment and/or Methods

- a. The use of spray adjuvants has permitted effective weed control with less material per acre.
- b. Techniques of delayed planting coupled with nonresidual herbicides has minimized or avoided residues in crops.
- c. Selected placement of herbicides has reduced the amount of material needed and lessened the problem of residues.
- d. Improved methods of determining the various agricultural chemicals in soil and water have resulted in improvements in extraction and cleanup.





Target V--To determine the comparative costs of the various methods of controlling insects and the economic effects of restrictions on the use of toxic chemicals in agricultural production.

#### Survey of Pesticide Use

A total of 11,700 completed questionnaires were obtained from farms distributed throughout 47 States containing information on farm characteristics, crop and livestock production, pesticide use and pest control practices.

#### Economic Appraisal of Damaging Pesticide Residues Relative to the Use of Water

A mail inquiry was completed covering major water pollution control agencies and experiment stations in each of the 48 contiguous States.

Target VI--Educate the public concerning the safe and proper use of pesticides.

#### Chemical Information Centers

All States have established a Central Chemicals Information Center in one or more locations.

#### Extension Service Review

The April 1965 Extension Service Review was devoted to the safe and proper use of pesticides.

#### Distribution of Materials

The FES Chemical Leader has distributed over 125,000 pieces of literature relating to pesticide chemicals to their State counterparts in fiscal year 1965.

Target VII--Establish and maintain a Pesticides Information Center to support research on pesticide projects.

The Pesticides Information Center began regular publications of its biweekly indexing journal--Pesticides Documentation Bulletin--in March, 1965.

A contract to design and program a computer-based information storage, retrieval, and publication system was let.

Target VIII--To coordinate the pesticide research, education and control efforts of the U. S. Department of Agriculture with the efforts of other Federal Agencies and with State and Municipal organizations.

An interagency research work conference was sponsored, in cooperation with the Departments of Interior and Health, Education, and Welfare.



A multidiscipline, interagency national symposium on the science and art of pest control is being developed under contract with the National Academy of Sciences -- National Research Council.

Support is being given the preparation and publication of seven manuals on the principles of pest control through a contract with the National Academy of Sciences -- National Research Council.





### NEW PROJECTS INITIATED IN FISCAL YEAR 1965

A total of 108 new pesticide-related research line projects were approved during fiscal year 1965. Fifty of these were in-house projects and 5 were contracts or grants. In addition, 40 pesticide-related projects were revised or superceded in fiscal ear 1965.

Examples, by target, of new projects initiated during fiscal year 1965:

#### Target I:

1. Biological control of weeds with plant disease organisms.
2. Biological control of aphids attacking potatoes.
3. Breeding peanuts that resist damage from the southern corn rootworm.
4. Breeding cotton for nematode resistance.
5. The effect of predators and parasites on the breeding potential of mosquitoes.
6. Effects of soil management and soil fumigation on control of plant-parasitic nematodes.
7. Use of electromagnetic, sonic, and ultrasonic energy to control cotton insects.
8. Flowing steam under vacuum to control tobacco insects.
9. Control of insects associated with swine production without the use of insecticides.

#### Target II:

1. Basic studies on radiation sterilization of insects .
2. Physiological studies on insect growth and development.
3. Effects of mutagenic chemicals on insect reproduction and heredity.
4. Nature and expression of resistance in Eastern White Pine to infection by Cronartium ribicola.
5. Nature of aphid resistance in alfalfa.
6. Effects of controlled gases on pathogens causing postharvest decay of horticultural crops.
7. The effect of stocking rate and rotational grazing on internal parasitism in beef cattle.



8. The metabolic effects of pesticide residues in body fat of rats on different diets.

Target III:

1. Detection of chlorinated insecticide residues in animal products and in livestock feeds.
2. Uptake, translocation, and cycling of residual pesticides by woody plants.
3. Principles and practices to control Johnsongrass in soybeans.
4. Controlling tobacco diseases with chemicals not leaving harmful residues.
5. Develop insect repellents for use on food packages and as grain protectants.
6. Develop improved equipment for application of agricultural materials from fixed-wing aircraft.
7. Dispersal of concentrated or undiluted insecticides for improved mosquito control.

Target IV:

1. The fate and behavior of insecticides in various soils as influenced by their continued use in crop production.
2. Pesticide pollution of farmstead water supplies.
3. Physiological aspects of accumulation, persistence, and fate of pesticides in plants.
4. Effects of selected herbicides on the nutritional composition and quality of food crops.
5. Pesticide residues ingested by finishing and reproducing beef cattle.
6. Effects of fumigation of stored wheat on vitamin content and on baking performance.
7. Nutrient composition of eggs and quality of the meat from hens treated with malathion.

Target V:

Economics of pesticide use in agriculture.





UNITED STATES DEPARTMENT OF AGRICULTURE  
Funds Available for Pesticides Research and Education Activities  
By Program, Fiscal Years 1964, 1965, and 1966--and 1967 Estimates  
(Thousands of Dollars)

Program	1964	1965	1966	1967 Estimates
1. Biological and non-pesticidal methods.....	13,928	23,591	24,576	23,400
2. Basic research.....	11,010	14,886	15,350	14,880
3. Improved conventional pesticides and methods of application.....	9,217	13,281	13,744	13,057
4. Toxicology, pathology, fate of pesticides and their effects on food quality.....	1,233	3,937	4,214	4,041
5. Economic studies on costs and returns.....	-	505	538	536
6. Intensified extension education.....	2,000	4,201	4,203	4,203
7. National pesticide information center.....	-	204	206	262
8. Interdepartmental coordination.....	-	250	250	250
TOTAL RESEARCH & EDUCATION	37,388	60,855	63,681	60,629



UNITED STATES DEPARTMENT OF AGRICULTURE  
Funds Available for Pesticide Research and Education Activities  
by Agency, Fiscal Years 1964, 1965, 1966  
and 1967 Estimates  
(Thousands of Dollars)

Agency	1964	1965		1966		1967 Est.
		Program	Total	Program	Total	
		Facilities		Facilities		
<b>RESEARCH:</b>						
Agricultural Research Service.....	24,307	38,812	40,618	40,207	48,514	39,284
Forest Service.....	4,086	6,622	6,672	6,672	7,522	6,672
Economic Research Service.....	-	505	505	508	508	509
Cooperative State Research Service.	6,995	10,261	13,503	11,035	11,635	9,448
National Agricultural Library.....	-	204	204	206	206	262
Subtotal, Research	35,388	56,404	61,502	58,628	68,385	56,175
<b>EDUCATION:</b>						
Federal Extension Service.....	2,000	4,201	4,201	4,203	4,203	4,203
<b>COORDINATION:</b>						
Office of the Secretary.....	-	250	250	250	250	250
TOTAL, Research & Education	37,388	60,855	65,953	63,081	72,838	60,628





UNITED STATES DEPARTMENT OF AGRICULTURE  
Funds Available for Pesticide Research Facilities by Agency, Fiscal Years 1965 and 1966  
(Thousands of dollars)

Agency & Facility	1965	1966
<u>Agricultural Research Service:</u>		
Facilities for livestock insects and toxicological and pathological effects of pesticides on livestock. College Station, Texas (Total cost \$3,250,000).....	260	2,990
Facilities for the control of plant disease, nematodes and insects, Beltsville, Md. (Total cost \$3,225,000).....	338	-
Insect attractants and basic research laboratory. Gainesville, Florida (Total Cost \$2,000,000).....	160	1,840
Stored products insects laboratory. Savannah, Georgia.....	800	-
Weed research laboratory. Stoneville, Mississippi (Total Cost \$1,700,000).....	136	1,564
Cotton disease research facilities. College Station, Texas (Total cost \$700,000).....	56	644
Western insects research facilities. Tempe, Arizona (Total cost \$700,000).....	56	644
Facilities to develop procedures and methods to avoid water pollution.		
Durant, Oklahoma.....	-	500
Plans for cereal rust laboratory. St. Paul, Minnesota (Total cost \$650,000).....	-	50
Plans for grain marketing research laboratory. Manhattan, Kansas (1/3 of laboratory relates to pesticides research) (Total cost pesticide-related \$1,128,000).....	-	75
Total, ARS Research Facilities	1,806	8,307
<u>Forest Service:</u>		
Forest and range experiment station, Berkeley, California.....	50	-
Basic research, New Haven, Connecticut.....	-	850
Total, Forest Research Facilities	50	850
<u>Cooperative State Research Service:</u>		
Facilities grants to state experiment stations.....	3,242	600
TOTAL USDA.....	5,098	9,757



PART II

DETAILED PROGRESS REPORT  
of  
PESTICIDES RESEARCH AND EDUCATION  
by  
TARGET AND AGENCY





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PESTICIDES PROGRAM  
Fiscal Year 1965

MISSION: The reduction and eventual elimination of the need for using hazardous pesticides in agricultural production, processing, and marketing.

Targets:

- I. To control plant pests and diseases and animal parasites by non-pesticidal methods.
- II. To gain knowledge of the biology, ecology, physiology, pathology, metabolism, and nutrition of insects, plants and animals in order to develop safe means of control.
- III. To develop less persistent conventional pesticides, improved methods of application, and detection methods of determining residues in the processing and marketing of agricultural commodities.
- IV. To determine the toxicological and pathological effects of pesticides and other agricultural chemicals in livestock; to determine the fate and effect of residues in soils, crops, and farmstead water supplies; and determine the effects of trace levels of pesticides occurring in our current food and feed supplies.
- V. To determine the comparative costs of the various methods of controlling insects and the economic effects of restrictions on the use of toxic chemicals in agricultural production.
- VI. To educate the public concerning the safe and proper use of pesticides.
- VII. To establish and maintain a Pesticides Information Center to support research on pesticide projects.
- VIII. To coordinate the pesticide research, education and control efforts of the U.S. Department of Agriculture with the efforts of other Federal Agencies and with State and Municipal organizations.



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I. To control plant pests and diseases and animal parasites by non-pesticidal methods.

A. AGRICULTURAL RESEARCH SERVICE

1. Division: Animal Husbandry Research

APPROACH--Ecological Control

Problems and Progress:

a. Bovine mastitis

Intramural--Methodology research has been conducted on the reliability of indirect tests for mastitis infection as compared to direct microscopic counting of body cells in milk samples. The use of body cell counts alone is not necessarily an indication of udder infection. Studies are in progress regarding the influence of various types of contaminated environment on udder infections. Beltsville, Md.

b. Flies in dairy barns

Intramural--The effectiveness of electrocutor gridscreens placed in windows plus an indoor electrocutor trap with black light lamps was evaluated in two calf barns where large numbers of house flies and stable flies were present. Although many flies were killed, no substantial reduction of the fly population occurred. Studies on the control of face flies indicated that control measures should be investigated which will destroy the flies when they are not on the cattle. The increased funds received have provided for research on the area requirements for effectively controlling the breeding sites of flies in and around dairy barns. Beltsville, Md.

Extramural--Investigations to determine the effectiveness of mechanical sanitation in reducing populations of house flies and stable flies on dairy farmsteads. Louisiana State University.

c. Pesticide residues in swine

Intramural--With the new funds a study was initiated on the infestation of swine with internal parasites when swine pens are washed daily versus two-weeks washing versus shoveling out of excess manure. All three of these manual practices were compared to chemical control of the parasites. The research is still in progress. Beltsville, Md.



Extramural--The effectiveness of swine management systems of housing and waste disposal for the control of fly and other insect propagation without insecticides. Purdue Research Foundation.

## 2. Division: Animal Disease & Parasite Research

### APPROACH--Biological Control

#### Problems and Progress:

##### a. Blackhead of turkeys

Intramural--Turkeys inoculated rectally with blackhead parasites grown in test tubes for five years were reasonably well protected against experimental exposure to blackhead by rectal inoculation of fresh parasites. When the fresh parasites were administered to birds by feeding them the vectors (earthworms or eggs of the poultry cecal worm) protection was minimal. Nevertheless, leads provided by this work may enable progress to be made in developing biological control measures applicable to parasitic diseases of livestock and poultry generally. Beltsville, Md.

Extramural--Research on histomoniasis, commonly called blackhead of turkeys, a parasitic disease caused by the protozoan, Histomonas meleagridis, a major cause of death losses in the production of turkeys. Texas Agricultural Experiment Station.

##### b. Cattle lungworm

Intramural--Research has demonstrated for the first time under controlled experimental conditions that a species of livestock can be made resistant to one of its helminths by prior infection with another species of helminth that is not adapted for maturation in this host species and normally occurs and matures in another class of livestock. Immunity to the cattle lungworm was produced experimentally in young calves and short yearlings by oral vaccination with infective larvae of the thread lungworm of sheep. Four of the five vaccinated calves were highly resistant or immune to the establishment of mature cattle lungworms, whereas each of the controls acquired a substantial patent infection. The smallest dosage per vaccination given to young calves was 5,000 larvae. This dose was too pathogenic for use for immunization in early calfhood, but short yearlings tolerated repeated vaccination with about 2,000 larvae very well. Beltsville, Md.

Extramural--To intensify research on methods for the control of helminth parasites of cattle, sheep, and poultry. University of Minnesota.





c. Diagnosis of equine babesiosis

Intramural--A diagnostic antigen, made from horse blood with 8% or more of the red blood cells containing parasites (Babesia caballi) proved sufficiently potent to fix complement (complement fixation, CF, test) satisfactorily, and to form good diagnostic lines in another test (ager gel, AG, diffusion test); evaluations of the antigen involved use of blood from experimental horses in various stages of the disease. Preparation of this strong antigen augurs well for the early development of a diagnostic tool that is accurate and reliable. Beltsville, Md.

d. General animal parasite control

Extramural--To intensify the present research with special emphasis on immunogenic and pathogenic evaluations of populations of Haemonchus contortus as a means of determining their potentials in biological control programs. Wisconsin Agricultural Experiment Station.

3. Division: Crops Research

APPROACH--Ecological Control

Problems and Progress:

a. Cotton Boll Rots

Intramural--Increased funds accelerated studies which showed that the cultural practices such as irrigation, spacing, and fertilizing affect chemical composition of the cotton boll which, in turn, affects severity of boll rots.

b. Seed fungi

Intramural--At Corvallis, Oregon, treating seeds with aerated steam gave excellent eradication of several disease fungi carried on the surface and inside red clover seed.

c. Citrus viruses

Intramural--In Texas, 19 varieties of citrus have been indexed for viruses to provide nurserymen with virus-free budwood to produce more productive and longer-lived trees.

d. Leaf spot of tung

Intramural--Mycosphaerella leaf spot of tung was partially controlled and tung nut quality and yield improved by cultivation of orchard floor to cover infected leaves.



e. Crown stem rot and cyst nematode in soybeans

Intramural--Rotation with corn gave control of crown stem rot and cyst nematode in soybean trials at Ames, Iowa. When soybeans followed 5 years of corn, yields were more than double those following 5 years of soybeans.

Extramural--Investigations designed to determine the effect of nematodes and environmental influences on incidence of nematode injury to soybeans. Purdue Research Foundation.

f. Stem rot of peanuts

Intramural--The possibility of control of stem rot of peanuts by crop rotation was indicated in greenhouse tests in Alabama where oat residues inhibited germination of resting bodies (sclerotia) of the pathogen.

g. Plant pathogens

Extramural--Investigations designed to determine the relation of natural and modified soil microenvironment and soil microflora to the survival of soilborne plant pathogens economically important in the Midwest. University of Nebraska.

h. Johnson grass in soybeans

Extramural--Investigations designed to develop new principles and improved practices for the control of Johnson grass in soybeans under conditions typical of the Middle Mississippi Valley area. University of Missouri.

APPROACH--Biological Control

Problems and Progress:

a. Tree fruit diseases

Intramural--Increased funds provided for a scientist to investigate use of bacteriophages as biological controls of tree fruit diseases and to reduce the need for hazardous spray chemicals.

b. Root rot

Intramural--A major breakthrough was made in biological control of *Aphanomyces* root rot of peas, sugarbeets, and other crops by findings that organic materials containing reduced sulphur compounds, such as cabbage, when incorporated in the soil provided effective control. The increased funds for 1965 permitted expansion of this and related research.



c. Aquatic weeds

Intramural--Biological agents showing promise for control of aquatic weeds, include a large fresh-water snail in Florida and two genera of fish in California.

d. Nematodes

Intramural--Research on biological control of nematodes at several locations is yielding significant information. For example, soybean cyst nematode was less damaging in rotations with cotton or with resistant varieties of soybeans; growing crotalaria and marigolds controlled most ectoparasitic and root-knot nematodes; but conversely, some crops and weeds increase parasitic nematode populations.

Extramural--Investigations on the competition of nematodes and soil microorganisms as affected by soil conditions and amendments. Florida Agricultural Experiment Station.

Extramural--Investigations on the modifying effects of soil management and biological changes on nematode populations following nematocidal and soil amendment treatments. University of California.

Extramural--Research on evaluating nematode damage to soybeans. Alabama Agricultural Experiment Station.

e. Weeds

Extramural--Investigations to detect, collect, isolate, purify, identify, and, if feasible, synthesize stimulants, inhibitors, and toxicants which may be released by certain weeds, and to characterize the effect of such on germination and seedling growth of other weed and crops species. Battelle Memorial Institute.

Extramural--Study of phytopathogens as weedcontrol agents. Stanford Research Institute, Menlo Park, California.

f. Johnson grass

Extramural--Basic studies on the biochemical cytology of the development of the quiescent state of plant embryos and in the rhizomes and buds of Johnson grass. Texas A&M University.

APPROACH--Genetical and Varietal Resistance

Problems and Progress:





a. Cereal leaf beetle

Intramural--Approximately 30,000 varieties of wheat, oats, and barley have been screened for resistance to cereal leaf beetle using increased funds; and good resistance has been located in wheat.

Extramural--Research on the sources of resistance in wheat, barley, and oats to the cereal leaf beetle. Michigan Agricultural Experiment Station.

b. Corn viruses

Intramural--Two corn inbred lines resistant to corn stunt and two lines resistant to maize dwarf mosaic have been developed.

c. Corn rootworm.

Intramural--Resistance of the corn rootworm to insecticides has prompted research which has located corn varieties tolerant to this important corn pest.

d. Stem rust

Intramural--A new wheat germ plasm has been developed with stem rust resistance derived from rye.

e. Plant nematodes

Intramural--Long a neglected means of controlling one of the most destructive of crop pests, breeding resistance is making progress including development of nematode-resistant cotton breeding stocks adapted to both the Southeast and Southwest; discovery in the mountains of Peru of new resistance to golden nematode of potato in the variety Shiri; release of three burrowing-nematode-tolerant citrus rootstocks and four grape rootstock selections resistant to nematodes; release of the cyst nematode-resistant soybean variety Pickett; and discovery of nematode-resistant germ plasm of cantaloupes. The new funds have stepped up this research.

Extramural--Research on the nature of mechanisms of resistance in alfalfa to the stem nematode. North Carolina Agricultural Experiment Station.

Extramural--Investigations designed to determine the mechanism of resistance in peas to the stem nematode. Maryland Agricultural Experiment Station.



Extramural--Investigations designed to determine the effect of nematodes and environmental influences on incidence of nematode injury to soybeans. Purdue Research Foundation.

f. Cotton wilt

Intramural--Outstanding progress has been made in breeding cotton resistant to Verticillium wilt, and cotton breeding stocks have been developed which incorporate insect resistance associated with smooth leaf characters without nectary or glands.

g. Boll weevil

Intramural--The screening of cotton germ plasm for boll weevil arrestants, attractants, and repellents indicates sufficient variability in these bioactive compounds to be of use in a breeding program for tolerance or resistance.

h. Multiple diseases of strawberries

Intramural--Two new strawberry varieties with multiple disease resistance were introduced: Earlibelle, resistant to leaf spot and leaf scorch, and Sunrise, resistant to red stele, leaf scorch, and mildew.

i. Apple scab

Intramural--Research indicates three genes for resistance to apple scab, and promising selections have been distributed for evaluation.

Extramural--Investigations on the biochemical basis of resistance in apples to the apple scab disease. Indiana Agricultural Experiment Station.

j. Diseases and insects of oilseed and industrial crops

Intramural--Progress in breeding disease- and insect-resistant oilseed and industrial crops includes: Release of two safflower varieties, namely, Ute, resistant to rust, and Frio, resistant to Phytophthora root rot; development of breeding lines of castor beans resistant to capsule mold and drop and of sesame resistant to bacterial leafspot; release of varieties of guar, Hall and Mills, resistant to bacterial leafspot; and location of germ plasm of sunflower resistant to head moth.





k. Diseases of vegetable varieties

Intramural--Disease-resistant vegetable varieties released include: Yakima, a green snap bean resistant to curly top virus, and two potato varieties--Penobscot, resistant to leafroll virus, and Shoshoni, resistant to two soilborne diseases. Nearing release are tomatoes resistant to tobacco mosaic and curly top; potatoes resistant to late blight, sweetcorn resistant to corn earworm; onions resistant to soilborne diseases and insects; lima beans resistant to new races of mildew; and mimosa trees resistant to nematodes and root diseases.

l. Resistant breeding stocks

Intramural--Plant exploration to broaden the base of resistant breeding stocks continued with the collecting of 860 beans, 44 tomatoes, and 170 miscellaneous species in Central America and Mexico for screening for disease and insect resistance and with a preliminary survey of Central European countries for cereals resistant to cereal leaf beetle.

m. Southern corn rootworm--peanuts

Extramural--Investigations designed to develop laboratory methods of evaluating natural resistance of peanut germ plasm to the southern corn rootworm. North Carolina Agricultural Experiment Station.

Extramural--Screening peanuts for genetic resistance to the southern corn rootworm. Georgia Agricultural Experiment Station.

n. Rust in seed flax

Extramural--Investigations on the rust resistance in seed flax and the breeding of rust resistant varieties. North Dakota Agricultural Experiment Station.

o. European corn borer

Extramural--Basic research investigations on biochemical basis for resistance of maize to attack by the European corn borer. Iowa State University.



p. Sweetclover weevil

Extramural--Basic research investigations on the nature of the resistance of Melilotus infesta to the sweetclover weevil. University of Nebraska.\*

q. Spotted alfalfa aphids and the pea aphid

Extramural--Research on the mechanisms of resistance in alfalfa to the spotted alfalfa aphid and to the pea aphid. Nevada Agricultural Experiment Station.

r. Potato leafhopper

Extramural--Basic studies on the nature and significance of plant alkaloids in potato leafhopper-host relations involved in plant resistance. Iowa State University of Science and Technology.\*

s. Black rot

Extramural--Basic studies on the genetic nature of inheritance of resistance to black rot in hybrids of selected wild clones of Vitis species and cultivars. Illinois Agricultural Experiment Station.

t. Yellow viruses

Extramural--Research on sugarbeets concerning influence of genotype and nutrition on physiological changes induced by yellow viruses. California Agricultural Experiment Station.

\* Participation with Entomology



#### 4. Division: Entomology Research

##### APPROACH--Ecological Control

###### Problems and Progress:

###### a. European corn borer

Intramural--Tests with Bacillus thuringiensis for control of the European corn borer continued to demonstrate potential usefulness as substitute for chemical pesticides. Granular formulations provided as good control as DDT. Ankeny, Ia.

###### b. Pea aphids and potato aphids

Intramural--A technique was devised to develop populations of aphid parasites in the higher elevations where pea aphids are abundant on alfalfa during the summer for subsequent release in the fall in alfalfa fields near Walla Walla as the aphid population increases, resulting in a high ratio of parasites to aphids in the spring and early summer as the pea crop is developing. Yakima, Washington.

Extramural--Aphids infesting potatoes. Maine Agricultural Experiment Station.

###### c. Boll weevils

Intramural--The parasite, Bracon mellitor, was reared successfully. Females released in a cotton plot maintained a consistently high population of this parasite until frost with 48% of weevil larvae being parasitized. Boll weevils were infested with Mattesia grandis spores in field cage tests. The microsporidian was produced in sufficient quantities for field tests by infecting boll weevil larvae developing in the rearing medium. A dosage equivalent of 100 diseased larvae per acre of the nuclear polyhedrosis virus was as effective as the standard insecticide in field experiments at several locations. State College, Miss.

###### d. Sugarbeet diseases

Intramural--Studies have shown that gradual increase of "yellows" in wild host plants near fields planted in successive years to sugar beets is correlated with a decline in production in the beet fields. The green peach aphid, an established vector of





beet western yellows overwinters successfully among the wild host plants in ecological niches provided by drainage ditches and sheltered locations. Increased funds have provided for a large area test to determine if sugarbeet diseases can be eliminated by destroying the overwintering host plants of the aphids which would reduce the need for chemical pesticides.

e. Pyralid stalk borers

Extramural--Basic research investigations on ecological factors affecting the efficiency of Trichogramma spp. as parasite of pyralid stalk borers. Louisiana State University.

f. Rhodesgrass scale

Extramural--Investigations to determine the most satisfactory and economical method of mass producing and distributing Neodusmetia sangwani, a parasite of Rhodesgrass scale, and to evaluate its effectiveness for control of that pest. Texas Agricultural Experiment Station.

g. Aquatic weeds

Extramural--Basic studies of insects associated with aquatic weed pests of foreign origin in Louisiana. Louisiana State University.

h. Insects and weeds

Extramural--A study and report on "A world review of parasites, predators, and pathogens introduced into new habitats against injurious insects and weeds." University of California.

Extramural--A study of the insects that feed on rangeland weeds of foreign origin in the State of Idaho. Idaho Agricultural Experiment Station.

Extramural--Basic research on the biology and host relationships of tachinid parasites of insects in the State of Washington. Washington State University.

Extramural--Studies to test insect viruses for mammalian toxicity and pathogenicity. Rosner-Hixson Laboratories.

Extramural--Basic research on the selection and development of superior strains of insect parasites and mite predators. Missouri Agricultural Experiment Station.



i. Mosquitoes

Extramural--Investigations to identify and characterize pathogens which affect mosquitoes for use as biological agents for control of mosquitoes in irrigated farming areas. State of California Department of Public Health.

Extramural--Investigations on the effect of predators and parasites on the breeding potential of mosquitoes found in coastal-marsh area of Louisiana. McNeese State College.

j. Codling moth and salt-marsh caterpillar

Extramural--An investigation to develop methods of rearing the codling moth and the salt-marsh caterpillar to produce specific nuclear polyhedroses viruses of these insects. Ohio Agricultural Experiment Station.

k. Fall armyworm

Extramural--An investigation of methods to rear the fall armyworm in order to produce specific nuclear polyhedrosis virus of this insect. Maryland Agricultural Experiment Station.

l. Red-banded leaf roller

Extramural--Conduct of investigations to develop new and improved methods to rear on semi-artificial media, the red-banded leaf roller and to produce nuclear-polyhedrosis virus-infected insects from such rearings. Rutgers Agricultural Experiment Station.

m. Cereal leaf beetle and ground beetle

Extramural--Basic research investigations on microbiology and pathologies of the cereal leaf beetle. Ohio Agricultural Experiment Station.

Extramural--Basic studies on the nature and significance of the life history and ecology of Lebia analis Dej., an important ground beetle predator. Arkansas Agricultural Experiment Station.

Extramural--Parasites of cereal leaf beetle. Michigan Agricultural Experiment Station.





n. Flies

Extramural--Basic research on predaceous mites infesting flies in poultry droppings. University of California.

o. Spider fauna and spider mites

Extramural--Basic research investigations of the spider fauna of San Joaquin Valley cotton fields and studies of their ecology and biology. University of California.

Extramural--Natural enemies of phytophagous spider mites. University of Missouri.

APPROACH--Electrical and Mechanical Control

Problems and Progress:

a. Tobacco insects

Intramural--An integrated program for control of tobacco insects involving the use of light traps, hand picking of larvae, application of systemic insecticides to the soil and destruction of weeds and stalks has reduced the use of conventional pesticides on shade grown tobacco.

b. Tympanate moths

Intramural--Sound in the range of 21 to 50 Kc disrupted normal flight patterns in studies of a number of tympanate moths including Heliothis zea. In preliminary studies the high frequency capacitor transducer developed for bollworm studies was effective in reducing the attractiveness of one of a pair of black light traps to tympanate moths. Florence, South Carolina.

APPROACH--Sterility methods of control

Problems and Progress:

a. Mexican fruit flies

Intramural--Sustained releases of chemically sterilized Mexican fruit flies for the second season in Mexico along the California border to prevent establishment of possible infestations from Mexican interior, replaced the chemical spray program previously employed by regulatory agencies. Research to improve sterilization techniques has been stepped up. A bait-chemosterilant experiment in a small mango grove in Mexico protected the mango crop from fruit fly emergence. Mexico City, Mexico.



b. Bollworm and boll weevil

Intramural--A large scale field experiment in Alabama combining diapause control with spring insecticide treatments or release of sterile (apholate treated) males reduced boll weevil populations to very low levels. State College, Mississippi.

Intramural--Metepa sterilized males reduced pink bollworm populations 80-90% from that of an untreated check in a large cage test simulating field conditions. Female pink bollworms sterilized with metepa were competitive with normal males. Brownsville, Texas.

c. Chemosterilants

Intramural--Studies are being conducted on the relationship of the chemical structure of two chemosterilants, tepa and hempa, to their sterilizing activity. Beltsville, Md.

Extramural--Synthesis of organic compounds for use in investigations on insect attractants and chemosterilants. Midwest Research Institute.

d. Mosquitoes

Intramural--A colony of Aedes aegypti mosquitoes which is more resistant to the sterilizing action of apholate than the normal colony of the same species has been developed. Biochemical studies to determine the mechanism of this resistance was initiated. Gainesville, Fla.

e. Eye gnat

Extramural--Basic research on the population dynamics, sterilization, and attractants for the eye gnat, Hippelates pusio Loew. University of Florida.

f. Oriental fruit moth

Extramural--Basic studies on the nature and significance of chemosterilant and attractant techniques for eradication of the oriental fruit moth. Colorado State University.



g. Navel orangeworm

Extramural--Basic studies on the nature and significance of sex pheromones and gamma radiation-induced sterility of the navel orangeworm, Paramyelois transitella (Walker). California Agricultural Experiment Station.

APPROACH--Insect attractants

Problems and Progress:

a. Pink bollworm

Intramural--The sex attractant produced by virgin females of the pink bollworm moth has been identified chemically and a 16-step synthesis of the attractant has been devised and is in progress to fully confirm the structure. Meanwhile extracts of the natural attractant are being prepared from female moths and supplied regularly to the Plant Pest Control Division for use in survey traps in the Southwest and for research on use in control. Progress is also being made in fractionation and purification of sex attractants from the banded cucumber beetle, southern armyworm, and codling moth. Beltsville, Md.

Intramural--Use of sex lure traps failed to reduce pink bollworm field infestation. Lack of isolation and other factors contributed to the ineffectiveness. Brownsville, Texas.

b. Peach tree borer

Intramural--Strong sex attractants in females of the lesser peach tree borer and the red-banded leaf roller have been demonstrated and extracted. Research to improve laboratory rearing techniques for these two insects has been intensified to provide adequate females for preparation of extracts. Vincennes, Ind.

c. Hornworms

Intramural--Populations of hornworms on tobacco can be strongly suppressed by use of black light traps either alone or in combination with late season stalk cutting to prevent moth development. Use of caged living virgin female moths in combination with light traps greatly increased catches of male moths. Oxford, North Carolina.





Extramural--Basic research on the sex attractant of the tobacco hornworm, Protoparce sexta. University of Wisconsin.

d. Boll Weevils

Intramural--The response of boll weevils to a narrow band of light peaking at 510 nano-meters increased with intensity up to approximately 40 microwatts/cm<sup>2</sup>. A rapid laboratory technique involving simple apparatus for bioassaying plant attractants for the boll weevil was developed. State College, Miss.

Intramural--A stem treatment (CL-47031) on large fruiting cotton, combined with foliar feeding stimulant sprays, resulted in considerable boll weevil mortality. Significant differences were found in boll weevil feeding extracts from seven species of Malvaceae. College Station, Texas.

e. Green peach aphid

Extramural--Basic studies on the influence of electromagnetic energy on green peach aphid. Purdue Research Foundation.\*

f. Tobacco budworm

Extramural--Basic research on the sex attractant of the tobacco budworm, Heliothis virescens. University of Michigan

g. Alfalfa weevil

Extramural--Basic research on attractants and stimulants for the alfalfa weevil. Virginia Polytechnic Institute.

h. Various pests

Intramural--Isolated areas for large area tests have been initiated at the island of St. Croix in relation to methods and on various pests such as hornworms, budworms, pink bollworm and corn earworm. Other insect pests will be included as research progresses.

Extramural--Investigations to determine insect attraction response and communication in the infrared spectral region for use in the control of insects. University of Michigan.\*

Extramural--Basic research investigations on the attraction and concentration of insect predators by non-toxic chemical stimuli. University of Minnesota.

\*Cooperation with Agricultural Engineering



## APPROACH--Genetic and Varietal Control

### Problems and Progress:

#### a. Corn pests

Intramural--Studies on the nature of corn plant resistance have been expanded. Tests have shown that physiological changes in corn silk initiated by fertilization is associated with increased corn earworm survival. A feeding arrestant-stimulant has been extracted from corn. Preference of extracts of plant fruiting bodies over extracts of vegetative parts were shown by larvae of the corn earworm, fall armyworm, and budworm. Tifton, Ga.

#### b. Cereal leaf beetle and Hessian fly

Intramural--Research was initiated to evaluate and study the combination of resistance in small grain varieties to cereal leaf beetle and Hessian fly. Four of the hundred lines of Hessian fly resistant wheat showed some degree of resistance to feeding by the beetle. Lafayette, Indiana.

Intramural--Over 10,000 small grain accessions were evaluated for cereal leaf beetle resistance--none of the oat or barley entries were found to possess a high level of resistance, although some differences were noted. However, 742 of the wheat entries had none to a trace of larval feeding and were considered resistant. East Lansing, Mich.

#### c. Soil infesting insects

Intramural--Laboratory and field studies were continued on sweet potato resistance to soil-infesting insects. The Louisiana breeding line L3-64 was found resistant to injury by the southern potato wireworm, a white grub and Diabrotica and Systema larvae. A significant resistance to cabbage looper injury existed among 13 breeding lines and several commercial varieties of cabbage. Charleston, S.C.

#### d. Bollworms, cotton fleahoppers and beet armyworm

Intramural--A glabrous-nectariless strain of cotton showed resistance to bollworms and the cotton fleahopper. Grape Colaspis and striped blister beetles, normally not pests of cotton, readily attacked glandless cottons. Brownsville, Texas.





Intramural--Strain 1514 had fewer bolls and squares damaged by bollworm than Delta Pine Smooth Leaf. Stoneville, Miss.

Intramural--Bollworm larvae reared on glandless cotton foliage were heavier and developed faster than those reared on glanded cotton foliage. High gossypol cotton varieties are more resistant to beet armyworm larvae than low gossypol varieties. Tucson, Ariz.

e. Potato leafhopper

Extramural--Basic studies on the nature and significance of plant alkaloids in potato leafhopper-host relations involved in plant resistance. Iowa State University of Science and Technology.\*

f. Sweetclover weevil

Extramural--Basic research investigations on the nature of the resistance of Melilotus infesta, a species of sweetclovers, to the sweetclover weevil. University of Nebraska.\*

g. Rice weevil

Extramural--Basic research on the control of damage by larvae of the rice weevil (Lissorhopterus orzophilus Kushel) by increasing plant tolerance. University of Arkansas.

h. Tarnished plant bug

Extramural--Basic research on evaluation resistance and screening alfalfa seedling for resistance to the tarnished plant bug and other mirid species. Kansas State University.

i. Alfalfa and pea aphids

Extramural--Nature of resistance in alfalfa to spotted alfalfa aphid and pea aphid. Nevada Agricultural Experiment Station.\*

j. Wheat stem sawfly

Extramural--Research on wheat stem sawfly, with special emphasis on causes of resistance, including investigations on histological structure of the wheat plant. North Dakota Agricultural Experiment Station.

k. Various insects

Extramural--Planning experimental work and procedures to be followed in research pertaining to insects attacking small grains, corn, and grasses.

\* Cooperation with Crops Research



5. Division: Agricultural Engineering Research

APPROACH--Electrical and Mechanical

Problems and Progress:

a. Vegetable Insects

Intramural--Research cooperative with the Purdue Agricultural Experiment Station indicates that tomato plants and fruit may be protected satisfactorily from hornworms and tomato fruitworms by blacklight insect traps without use of insecticides, but that adequate protection from cutworms was not provided by such traps. In cooperation with the Entomology Research Division and the California Agricultural Experiment Station, research has been initiated on the possible control of cabbage loopers with electric light traps. Some very favorable results on increased insect catches have resulted from combining female sex attractants with light traps. Lafayette, Ind; and Riverside, Calif.

b. Cotton Insects

Intramural--Use of a new fluorescent lamp in an insect trap has lured boll weevils into the trap, heretofore not accomplished by use of ultraviolet lamp attractants. In cooperation with the Entomology Research Division and the Pee Dee Agricultural Experiment Station, research on cotton insect control, particularly the bollworm, has been initiated using sound for attracting or repelling the insects. College Station, Texas; and Florence, S.C.

c. Tobacco Insects

Intramural--Investigations on the effectiveness of insect light traps covering a large area for the control of tobacco insect populations were continued. Hornworm population was less in the trapped area in 1964 than in 1963 and in 1962. Oxford, N.C.

Intramural--Engineering cooperation with the Kentucky Agricultural Experiment Station on hornworm control has provided mapping of trap installations, assistance in trap relocation to the desired 3 per square mile, and evaluation of trap design as related to insect capture. The first known evidence of the light response of the alfalfa weevil to light traps was shown. \* Lexington, Ky.

\*Participation with Entomology



Intramural--The initiation of basic studies on tobacco insect response to various physical attractants has been facilitated. Preliminary electro-physiological studies on tobacco hornworm moths tend to verify earlier response work made almost entirely in field studies. Blacksburg, Va.

Intramural--Preliminary work on an area population control study of the hornworm was initiated on St. Croix. This island of 84 sq. miles is being covered with 250 light traps and because of its location will not be subject to infestation from adjacent areas.\* St. Croix, V.I.

Extramural--Investigations on design and effectiveness of electric light traps for control of hornworms and other tobacco insects. Clemson Agricultural Experiment Station.

d. Flies infesting animals

Intramural--Additional tests were made on the responses of face flies to monochromatic light. The results confirmed that black-light is highly attractive under conditions of confinement and that wavelengths of light in the red and yellow spectral regions are unattractive.\*\* Beltsville, Md.

e. Grain insects

Intramural--Cooperative studies were conducted with the Purdue University Agricultural Experiment Station to determine the responses of cereal leaf beetles to electromagnetic radiation and whether light traps could be employed as a survey tool for this pest. While results are still inconclusive, they indicate that light traps will not be useful as a survey tool for the cereal leaf beetle in the presently infested area. Lafayette, Ind.

Intramural--Equipment built in 1964 to pulse modulate the output of the radio-frequency oscillators was utilized in efforts to improve the efficiency of the method for insect control. With pulse modulation, field intensity can be nearly twice that possible with continuous oscillation, but anticipated increases in insect mortality were not achieved generally. However, pulse modulation did increase the mortality of lesser grain borers treated in wheat. This work is cooperative with the Entomology Department, Nebraska Agricultural Experiment Station. Lincoln, Nebr.

\*Participation with Entomology.

\*\*Participation with Animal Husbandry and Entomology





f. Fruit Insects.

Intramural--A test of the usefulness of light traps in studying the flight habits of codling moths was conducted in orchards. The light traps proved to be more efficient and dependable than conventional bait traps and captured a more representative sample of the moth population.\* Yakima, Wash.

g. Design of electric insect traps

Intramural--Cooperative activities with the Plant Pest Control Division were continued on improvement of electric insect survey trap design.

Extramural--Investigations to determine insect attraction response and communication in the infrared spectral region for use in control of insects. University of Michigan.

h. Boll Weevil

Intramural--Studies on mechanical methods of destroying fallen cotton squares were continued. An improved model of the flail machine was built and tested to determine its efficiency in square destruction and its effectiveness in boll weevil control. In a portion of the tests pickup efficiency was 84.5 percent, and the killing efficiency of the machine was 96.3 percent on the immature weevils which passed through the flail units.\* Miss.

i. Corn Earworm

Intramural--Ultrasonics were investigated as a possible means of controlling insects on southern grain crops. Field work has been concentrated on repelling corn earworm moths, while laboratory work has been devoted primarily to destruction of eggs and larvae. Ultrasonics killed the first instar larvae of either the armyworm or earworm in less than 15 seconds. Georgia

j. Green peach aphid

Extramural--Basic studies on the influence of electro-magnetic energy on green peach aphid, Myzus persicae (Sulzer). Purdue Research Foundation.\*

\*Cooperation with Entomology Research



## 6. Division: Market Quality Research

### APPROACH--Insect Attractants

#### Problems and Progress:

##### a. Black Carpet Beetle

Intramural--The apparatus used for trapping and collecting natural attractants from insects was redesigned. Research on the isolation and identification of the attractant collected from black carpet beetles is progressing. Fresno, Calif.

Extramural--Basic investigations designed to isolate, identify and synthesize the sex attractant of the virgin female black carpet beetle. Stanford Research Institute.

### APPROACH--Electrical and Mechanical

#### Problems and Progress:

##### a. Stored-products insects

Intramural--The research on the use of light, radiation, and controlled atmospheric gases was expanded, and research on the use of sound was initiated. The ultraviolet and green light proved to attract stored-product insects even in the presence of food. Newly designed insect traps using these two wave-lengths of light are being evaluated under warehouse conditions. The increased funds make possible more basic and exact research. Savannah, Ga.

##### b. Tobacco moth

Intramural--Larvae and pupae of the tobacco moth were found to be extremely sensitive to the vacuum-steam flow process. Eggs of the moth and all stages of the cigarette beetle were more resistant. Richmond, Va.

### APPROACH--Ecological Control

#### Problems and Progress:

##### a. Stored-products insects

Intramural--Work on inert materials such as diatomaceous earths and silica aerogels was greatly expanded. Some additional work on





natural resistance to insect infestation by new corn breeds was started. Extensive laboratory and field tests on inert materials show biological effectiveness equal to or greater than presently used pesticides. Tifton, Ga.; Manhattan, Kansas.

Extramural--Investigations designed to synthesize safe and effective repellent compounds for prevention of insect infestation in stored food packages and agricultural commodities. Midwest Research Institute.



B. FOREST SERVICE

1. Division: Forest Insect Research

APPROACH--Ecological Control

Problems and Progress:

a. Dutch Elm disease - European elm bark beetle

Intramural--Promising results were obtained with an insect parasite of the smaller European elm bark beetle which transmits the Dutch elm disease. Research on rearing techniques enabled production of several generations of the parasite annually in the laboratory. Test results showed parasitism ranging from 20 to 80 percent. Delaware, Ohio.

b. Gypsy Moth

Intramural--A number of promising pathogens of the gypsy moth have been discovered in the field populations of this pest. New Haven, Conn.

c. Red pine scale

Intramural--Valuable information has been gained about a primary predator of the red pine scale, killer of young red pine. It has been found in the Northeast only where the scale is present. Research on it's morphology, mating, egg laying and feeding habits provided information needed to use it as a control. Though a 2-year population build-up of the scale occurs before the predator becomes effective, it appears that tree-killing is precluded thereafter. New Haven, Conn.

d. Balsam wooly aphid

Intramural--The predator Aphidecta oblitterata imported from Europe has been found to be the most promising enemy of the balsam wooly aphid in the Southeast. Studies recently revealed that it can survive on relatively light aphid populations, can be established by release of a few adults and in one year can become as abundant as native predators in the release site. North Carolina is the only area in North America where Aphidecta has become established. Research Triangle, N. C.



e. Ambrosia beetles

Intramural--Studies on ambrosia beetles, which bore into and degrade green stored hardwood logs, indicate that damage may be prevented with a continuous water spray applied to the logs. Such a treatment would prove physically and economically more practical than the application of benzene hexachloride presently used by the lumber industry. Gulfport, Miss.

APPROACH--Biological Control

Problems and Progress:

a. Insects

Intramural--Intensive study is being devoted to the role of blood cells in the mode of action of diseases in insects. A significant finding demonstrated that cells of the disease Bacillus thuringiensis are ingested by certain blood cells of the insect--but these blood cells are later destroyed. Corvallis, Ore.

Intramural--Discoveries have been made on the mutability and etiology of the insect disease Bacillus thuringiensis and its strains that are expected to have a considerable impact on the understanding of these organisms. Research Triangle, N. C.

Extramural--Bacterial isolation and identification study. University of Connecticut.

b. Hemlock looper

Intramural--Seven parasites were recovered from the destructive hemlock looper; two of the most effective ones were studied intensively. It was found that these were least active during the second and third instar of the looper. It is then that insecticide sprays are most effective. Thus, there is a compatibility between biological and chemical control and an opportunity for integrated control. Corvallis, Ore.

c. European elm bark beetle

Intramural--A feeding stimulant has been isolated from dry powdered elm bark. It may serve to provide a chemical basis for explaining host selection by the smaller European elm bark beetle and contribute toward control by trapping using chemical, chemo-sterilants or other control techniques. Delaware, Ohio.





Extramural--Isolation, identification and synthesis of pheromones of bark beetles. Stanford University.

Extramural--Rate of chemical messengers in the biology of bark beetles. University of California.

Extramural--Factors influencing the attraction movement and concentration of southern pine bark beetles. Duke University.

Extramural--Chemical investigation-host plant-elm bark beetles. Ohio State University

d. Gypsy moth and pine tussock moth

Extramural--Investigations of the microflora of healthy and diseased gypsy moth larvae. University of Connecticut.

Extramural--Pathogenicity of nuclear polyhedral virus, pine tussock moth. Pennsylvania State University.

e. Termites

Extramural--Control of wood destroying termites. University of Wisconsin.

f. Lepidoptera

Extramural--Pathology of double viral infections in Lepidoptera. Purdue University.

APPROACH--Sterility Methods Control

Problems and Progress:

a. Spruce budworm

Intramural--Promising results are indicated in studies of the effects of chemosterilants on the spruce budworm. Six chemosterilants are being studied and results are evaluated on the basis of percent mortality versus sterility. St. Paul, Minn.

b. Forest tent caterpillar and pine tussock moth

Intramural--Preliminary to this research the chemosterilants metepa and hempa were found effective against larvae of the forest tent caterpillar and pupae of the pine tussock moth. St. Paul, Minn.



c. European pine shoot moth

Extramural--Including sexual sterility in the European pine shoot moth. Washington State University.

APPROACH--Genetic and Varietal Control

Problems and Progress:

a. Bark beetles and other insects

Intramural--Controlled pollinations of pines were made in the investigation of inheritance of resistance of hosts to insect attack. Of primary concern is the inheritance of factors that control the quantity and composition of oleoresins; these materials are known to be related to resistance of trees against attack by bark beetles and other insects. Berkeley, Calif.

Intramural--Progress is being made in analyses to determine nature of inheritance of oleoresin production, as related to insect resistance, in pine tree parents and progeny that have been produced at the Institute of Forest Genetics. Berkeley, Calif.

b. Physical and chemical characteristics of the oleoresins

Intramural--Susceptibility of loblolly and shortleaf pine to tip moth attack and the resistance of longleaf and slash is apparently related to the nature of oleoresins in pines. Chemical and physical characteristics of pine resins are being investigated in an effort to explain the phenomena. An understanding of the physical and chemical characteristics of the oleoresins could lead to production of resistant pines through genetic or environmental manipulation. Athens, Ga.

2. Division: Forest Disease Research

APPROACH--Ecological Control

Problems and Progress:

a. Blister rust

Intramural--Evidence from samplings of blister rust distribution and from night breeze studies near Lake Superior have strongly reinforced the night-breeze-controlled spread-pattern of rust. The observations of lake breezes that carry spores show where spores impact and how they are carried. Since rust spread locations can be predicted from these spore transport routes, blister rust control can be improved. St. Paul, Minn.



b. Dwarf mistletoe

Intramural--Damage to Douglas-fir and ponderosa pine stands from dwarf mistletoe attack has been studied in the Pacific Northwest. The studies included silvicultural manipulations to favor growth of the trees and prevent the rapid spread of the pathogen. Portland, Ore.

c. Root rot

Intramural--Research to slow or stop the spread of Fomes annosus root rot from tree to tree or stump to tree is underway. Injection of soil fumigants at various depths and under different soil moisture conditions has varying effects on the fungus and on the host tree. Studies to determine effective dosage and soil moisture continue. New Haven, Conn.

d. Root nematodes

Intramural--Root nematodes injure tree roots directly and also provide infection courts for root pathogens. Soil fumigation results in marked increase in tree growth. Athens, Ga.

APPROACH--Biological Control

Problems and Progress:

a. Mycorrhizae of southern hardwood

Intramural--Studies of fungi associated with mycorrhizae of southern hardwood species were initiated. The first tree species selected for investigation was sweetgum. Two manuscripts dealing with the isolation and identity of the organisms have been prepared and are scheduled for publication in the near future. Stoneville, Miss.

APPROACH--Genetic and varietal control

Problems and Progress:

a. Blister rust resistance

Intramural--Induced mutation through seed treatment with ethyl methane sulfonate offers promise as a means of improving blister rust resistance in western white pine. Biochemical differences between resistant and susceptible trees are not sufficient for use in screening selections. Large savings can be made in hybridization work by using mixed-pollen crosses. Moscow, Idaho





b. Chestnut blight

Intramural--Inspection of long-term cooperative tests plots containing hybrid chestnuts and Chinese chestnuts revealed that after nine to seventeen years all fifteen plots contained some trees that showed promise in both chestnut blight resistance and growth characteristics. Grafts of some of the most promising have been distributed to other cooperators for further tests in other areas. Upper Darby, Pa.

c. Littleleaf disease

Intramural--Selections resistant to littleleaf disease have produced seed and progeny tests of seedlings from controlled pollinations are now under test on a severe littleleaf site. Inter-specific pine hybrids are under test on the same site. Athens, Ga.

d. Cronartium ribicola

Extramural--The nature and expression of resistance in Eastern White pine by Cronartium ribicola. University of Wisconsin.

e. Live oak decline and mortality

Extramural--Determining the cause of live oak decline and mortality in East Texas. Texas A&M University System.

3. Division: Timber Management Research

APPROACH--Genetic and varietal control

Problems and Progress:

a. Various insects

Intramural--Plantings of eight hybrid and native pines in the central Sierra Nevada of California were evaluated. The most promising hybrid was the backcross Jeffrey x (Jeffrey x Coulter). It showed little damage by insects, snow, or porcupines. This backcross hybrid, now being bred for outplanting on National Forests in California, should be an acceptable insect-resistant substitute for ponderosa and Jeffrey pines up to about 6,000 feet. Placerville, Calif.

b. Fusiform rust infection

Intramural--Fusiform rust infection of slash pine causes severe losses in the South. Progenies from rust-free and rust-infected



parents were exposed to intense rust infection in Mississippi. Infection in progenies from two rust-free parents was about 50 percent in contrast to 90 percent infection in progenies from other parents. The results confirm our earlier finding that rust resistance is heritable. Further, they emphasize the need of excluding all rust-infected trees from slash pine seed orchards and seed production areas. Gulfport, Miss.

c. White pine weevil

Intramural--The white pine weevil is the major cause of declining production and use of the valuable eastern white pine. The first progeny tests examined for weeviling show that resistance to this insect is genetically controlled. This finding points the way to a breeding program to develop weevil-resistant white pines. Rhinelander, Wis.

d. Sawflies

Extramural--Natural variation in susceptibility of pines to Neodiprion sawflies as a basis for the development of a breeding scheme for resistant trees. Yale University.



## C. COOPERATIVE STATE RESEARCH SERVICE

APPROACH--Biological, sterility and non-chemical methods or by use of attractants, etc.

Emphasis in this area is placed on biological control of insect pests using parasitic insects, viruses and microorganisms. The combination of biological and chemical control into integrated insect pest control is being investigated. Food and sex attractants and chemosterilants for insects are also receiving special attention. Biology and control by non-chemical methods of soil infesting fungi and the biological control and biology of nematodes in the soil, are being studied. The effect of temperature, ultrasonics and management on weed control are active lines of research, as also are coccidiosis and the enzymes produced by parasites in domestic animals.

APPROACH--Genetic and varietal resistance of plants

The research covers various phases of resistance of crop plants to damage from insects, mites, fungi, viruses and other pests. Breeding and selection for resistance to insects, mites, and diseases is in progress on onions and other vegetable crops, corn, sorghum and fruit crops. Resistance to insects and mites is being sought in cucumbers, alfalfa, small grains, bluegrass turf, pears and other crop plants. Resistance to disease is being studied in beans, tomatoes, potatoes and deciduous fruits.

APPROACH--Nonpesticidal control of insects attacking food, feed and fiber after harvest.

The research is on chemical and nonchemical measures for the protection of perishable food commodities during marketing and pesticide residues in agricultural commodities in marketing channels; resistance in storage of various varieties of grain sorghum to insects; effects of tranquilizing agents and other drugs on insects; and handling and packaging meat products to reduce or prevent pest damage in storage and marketing.





II. To gain knowledge of the biology, ecology, physiology, pathology, metabolism, and nutrition of insects, plants and animals in order to develop safe means of control.

A. AGRICULTURAL RESEARCH SERVICE

1. Division: Animal Husbandry Research

APPROACH--Basic Research

Problems and Progress:

Agricultural chemicals ingested by livestock

Intramural--With the new funds research has been initiated on the basic metabolism, fate and role of agricultural chemicals in livestock. Specific studies have been started on the metabolic fate of the triazine herbicides in animals. Other work was implemented on the availability of iodine in diiodosalicylic acid, the chemical used as a carrier of iodine in some mineralized salts. Tentative conclusions are that a major portion of this acid, when secreted in the urine, is still in the original form ingested. Microbiological studies have been devoted to developing and establishing techniques and methodology for the in vitro estimates of the extent of ruminal bacteria metabolism of agricultural chemicals. By using these techniques some 42 pesticides, insecticides, and herbicides have been incubated with rumen bacterial suspensions for 50 to 80 minutes without showing significant endogenous gaseous increases. This means that the chemicals were not being utilized by the bacteria and the chemicals also were not inhibiting the metabolism of the bacteria. Fargo, N. D.

2. Division: Animal Disease and Parasite Research

APPROACH--Basic Research

Problems and Progress:

a. Parasites

Intramural--In a pilot study, 36 lambs, all apparently parasite-free and in good health, have been raised to about 8 weeks of age. The study was begun with 40 lambs and there were 4 deaths; the mortality rate was not higher than that in a comparable group of lambs raised at the same time with their mothers. The lambs were taken at birth from ewes harboring natural infections of several parasites, placed in sterilized containers, transported immediately to specially prepared, well-heated sanitary nursing quarters, and bottle-fed a mixture



of condensed milk, water, corn syrup, and fish liver oil. After 6 weeks, the only feed was hay and grain. Special sanitary procedures, including daily sterilization of cage pans and water and feed containers, were practiced throughout. The attendants at all times wore clothing and rubber footwear sterilized usually daily or at least every 2 days.

The procedure devised, which has so far made possible the production of parasite-free and pathogen-free lambs, is expected to make possible experiments of types that heretofore could not be undertaken. The procedure is also expected to provide leads to form a basis for development of measures for the biological control of parasites. Beltsville, Md.

b. Parasite malformation

Intramural--Malformation of parasites may result from "safe" antiparasitic chemicals. Deformities have been found in numerous male specimens of the common stomach worm of sheep following exposure to therapeutic doses of phenothiazine. The percentage of male worms with deformities in exposed populations ranged 0 to 47 percent, whereas the percentage in unexposed populations ranged from 0 to .3 percent. The parts of the worms affected (spicules, gubernaculum, dorsal lobe and supporting ray of the bursa), because of their prominence and normally characteristic conformation, are used in systematics; consequently, the antiparasitic weakens current competence to distinguish species of livestock parasites. The deformities studies may be comparable to those recently reported in human medicine involving thalidomide.

It is important not only to recognize this extrinsic effect but also the potentials for attenuation, sterilization, and cross-immunization; and it could be significant to note the possibility of using parasites as a sensitive criterion of teratogenic effect. The findings described seem to add a new and special dimension to parasitological researches. Beltsville, Md.

c. Parasite nematodes

Intramural--Development of methods for in vitro cultivation of helminths has resulted in growth of 8 species of nematodes through one or all of their parasitic stages and in maintenance of selected populations for extended periods. A significant advance has been made with the demonstration that a tissue parasite (the swine kidney worm) can be grown on swine kidney cell tissue cultures. Since many helminths invade tissues for at least part of their parasitic life, the use of tissue cultures may provide the elusive missing link needed to complete the chain of successive laboratory-reared generations. Successful





cultivation of animal-free generations of parasitic nematodes will not only rank as a major biological accomplishment in itself but, more importantly, will open whole new vistas in the basic research of parasitological phenomena and in the enormous potentialities of non-chemical or biological control of injurious parasites. Beltsville, Md.

### 3. Division: Crops Research

#### APPROACH--Basic Research

##### Problems and Progress:

##### a. Effect of insecticides on cotton

Intramural--Physiological studies of the effect of pesticides on cotton seedlings indicate that phosphate insecticides delay fruiting and maturity.

##### b. Victoria blight of oats

Intramural--Important progress is being made in research on the biochemical nature of the mode of action of a toxin produced by a plant pathogen in inducing a plant disease--in this case, victoria blight of oats. Gainesville, Fla.

##### c. Barley yellow dwarf virus

Intramural--Attempts to purify and identify the barley yellow virus have finally been successful with the use of a special density gradient fractionator which allows work with viruses of very low concentration. Ithaca, N. Y.; Lincoln, Nebr.

##### d. Cereal rusts

Intramural--In epidemiology studies of cereal rusts, rust spores carried by early spring rain play an important role in development of epidemics by providing inoculum for early infections. St. Paul, Minn.

##### e. Viruses of corn

Intramural--Studies of two serious viruses of corn, identical in symptoms, show that corn stunt is confined to the South, has a limited host range, and is only leafhopper transmitted; while maize dwarf mosaic occurs in both the Southern States and Corn Belt, and can be transmitted mechanically and by aphids to a large number of hosts.





f. Plant viruses

Intramural--Methods of freeing plants from viruses were developed for (1) strawberries, by rooting excised tips from very young stolons, and (2) for grapes, by mist-propagating shoot tips from heat-treated plants. Oregon, California.

g. Citrus disease

Intramural--Research progress is slow on the serious stubborn disease of citrus, but progress made to date indicates that the disease is graft transmitted, and a promising indicator plant (Madame Vinous sweet orange) has been identified.

h. Soybean bacterial plant pathogens

Intramural--The use of fluorescent-labeled antibodies coupled with microscopic examination makes possible quick identification of soybean bacterial plant pathogens in order to facilitate research.

i. Molds

Increased funds permitted acceleration of studies of molds on agricultural products in relation to mycotoxins and to develop specific methods for study of microfloral succession on peanuts.

Extramural--Investigations to determine the presence of aflatoxin or other mycotoxins in peanuts, cotton and soybeans. Virginia Agricultural Experiment Station.

j. Seedborne bacterial diseases

Intramural--Research techniques valuable in studies to control seedborne bacterial diseases involve detection of infinitesimal amounts of infection on bean seed by bentonite flocculation, microagglutination, and antibodies conjugated with fluorescent dyes.

k. Nematode resistance and nematode damage

Intramural--Basic research which may lead to a rapid screening technique for nematode resistance was developed and consists of a precise sterile technique involving single larvae inoculation of sterile excised root tissue. Beltsville, Md.

Extramural--Research on evaluating nematode damage to soybeans. Alabama Agricultural Experiment Station.



Extramural--Investigations designed to determine the effect of nematodes and environmental influences on incidence of nematode injury to soybeans. Purdue Research Foundation.

l. Saltcedar

Intramural--Information developed basic to developing control measures for saltcedar is concerned with relationship of movement and storage of salts, particularly sodium in foliage, and the level of carbohydrates in roots. New Mexico.

m. Microbiological activity

Intramural--Progress was made on the nature of the effect of the herbicide, Amitrole, on microbiological activity. Beltsville, Md.

n. Cereal leaf beetle

Extramural--Research on the sources of resistance in wheat, barley, and oats to the cereal leaf beetle. Michigan Agricultural Experiment Station.

o. Sugarbeets

Extramural--Research relative to the chemical constituents of sugarbeets. Colorado Agricultural Experiment Station.

p. Johnson grass

Extramural--Investigations designed to develop new principles and improved practices for the control of Johnson grass in soybeans under conditions typical of the Middle Mississippi Valley area. University of Missouri.

q. Black point disease

Extramural--Basic research on the resistance of durum wheat kernels to black point disease. North Dakota Agricultural Experiment Station.

r. Short peach tree life

Extramural--Research on possible roles of cold injury in the short peach tree life problem. Georgia Agricultural Experiment Station.



#### 4. Division: Entomology Research

##### APPROACH--Basic Research

##### Problems and Progress:

##### a. Insect populations

Intramural--Studies were initiated to explore the possibilities of controlling harmful insect populations by manipulating photoperiods. Research now underway includes investigation of a number of aspects of the action of light on insects, such as measurement of light penetration into fruits, vegetables, cotton bolls, and soil and determination of the spectral characteristics of the light most effective in controlling diapause in insects. A study was begun to establish whether there is a circadian rhythm of variation in sensitivity of insects to insecticides. Tests are being conducted around the clock with pyrethrins against houseflies, cockroaches, and Japanese beetles. Beltsville, Md.

##### b. Mosquitoes and houseflies

Intramural--Basic research has provided a wealth of new information on the mechanisms of resistance to insecticides in mosquitoes and on housefly resistance to chlorinated hydrocarbon, organophosphorus and carbamate insecticides. Materials have been found that inhibit the resistance mechanisms in these insects. Studies are underway to determine the possibility of using such materials in the control of resistant flies and mosquitoes. Corvallis, Oregon.

Intramural--Studies have shown distinct differences in the behavior of different strains of the same species of mosquitoes or houseflies. This is an important discovery because it has a vital bearing on the use and efficiency of the release of sterile, diseased, or genetically inferior insects into natural populations for control purposes. Preliminary studies have indicated a genetic basis for strain differences. Additional research is underway to determine how these differences might be employed for practical control purposes. Several mutants of the housefly were isolated from normal and gamma-irradiated strains reared in the laboratory. Three of these have proved useful in the genetic analysis of insecticide resistance. Gainesville, Florida.

##### c. Boll weevil

Intramural--Pink adult boll weevils developed from larvae reared on dye containing Calco oil red dye. The marker color





was retained for 8 weeks and the females laid pink eggs. Other studies showed that the boll weevil absorbed fatty acids in its diet and stored some of them unchanged but modified the remainder to form other types of fatty acids. Palmitic acid may be changed to palmitoleic by desaturation, or its chain may be elongated by two carbon atoms to steric, which may then be desaturated to oleic. State College, Mississippi; Baton Rouge, Louisiana.

Intramural--Fatty acid percentages were different in boll weevils tolerant to carbaryl, Guthion, toxaphene, and toxaphene plus DDT than in those immune to them. The percentage of steric acid was higher and the percentage of palmitic acid oleic acids were lower in insecticide-susceptible weevils than in resistant weevils. Florence, S. C.

Extramural--A study of overwintered boll weevil emergence using isolated plots of cotton. Texas Agricultural Experiment Station.

Extramural--Study of boll weevil in high and rolling plains of Texas. Texas A&M University.

d. Toxicants in cotton plants

Intramural--Metabolism studies of SD-9129 in cotton plants indicated a metabolic route similar to that of Bidrin. Soil type influenced uptake of Di-Syston by cotton plants when the toxicant was applied to the soil. Much larger amounts were recovered from plants growing in light soil than in heavy soil. College Station, Texas.

e. Pear psylla

Extramural--Basic studies on the behavior of the pear psylla in Central Washington. Washington State University.

f. Cuban May beetle

Extramural--Basic studies of the biology of the Cuban May beetle. University of Florida.

g. Peach tree borer

Extramural--Basic studies on mass rearing and biology of the peach tree borer, Sanninoidea exitiosa (Say). North Carolina College.



h. Codling moth

Extramural--Basic studies on the influence and significance of photoperiod and light on diapause and development of the codling moth. Washington State University.

i. White-fringed beetle

Extramural--Basic research on the development of artificial rearing techniques for the white-fringed beetle. Auburn University.

j. Insect response

Extramural--Basic investigations on the comparative responses of irradiated and normal insects to gradients of light, temperature, and humidity. Georgia Agricultural Experiment Station.

Extramural--Basic research on the nature and significance of weather as a tool for prediction and behavior of field populations of insects. Clemson University.

k. Neoschongastia americana

Extramural--Basic research on the biology of the mite, Neoschongastia americana, which is a serious pest of turkeys. Georgia Agricultural Experiment Station.

l. Cutworm larvae

Extramural--Basic studies on the taxonomy, morphology, and ecology of cutworm larvae of the family Noctuidae in the order Lepidoptera. Cornell University.

m. Leaf hoppers

Basic studies on the nature and taxonomic significance of morphological characters of females of leaf hoppers. North Carolina State College.

n. Alfalfa seed chalcid

Extramural--Basic research on ovipositional behavior of the alfalfa seed chalcid to chemicals occurring naturally in alfalfa. University of Wyoming.



o. Horse flies

Extramural--Basic research on the biology and behavior of horse flies. University of Wyoming.

p. Cereal leaf beetle

Extramural--Basic research investigations on the behavior of the cereal leaf beetle as affected by climatic factors. Purdue Research Foundation.

q. Mites

Extramural--Basic research on ecology of mites within pomaceous tree fruit orchards. Brigham Young University.

5. Division: Market Quality Research

APPROACH--Basic Research

Problems and Progress:

a. Stored-product insects

Intramural--In addition to the studies on life histories and habits of stored-product insects, this project now includes basic research on the development of optimal diets and rearing conditions; effects of environmental factors on development, growth, and food reserves; and on hormonal control of intermediate metabolism. Savannah, Georgia.

Intramural--Basic information on respiration physiology of stored-product insects was obtained in studies designed to develop more effective fumigation techniques. The influence of dockage in grains on the attraction of insects was studied. Manhattan, Kansas.

Extramural--Basic research on biology, ecology, physiology and nutrition of stored-product insects. University of California.

Extramural--Basic studies of the reproductive potential and related physiological effects following sublethal doses of irradiation to stored-product mite pests. University of Georgia.

Extramural--Basic studies on the extent, nature, and significance of low temperature adaptation and chill-coma in stored-product insects. Iowa State University.





Extramural--Basic studies on the nature and significance of changes in activities of oxidative detoxication enzymes with the age and stage of stored-product insects. Iowa State University.

b. Tobacco moth

Intramural--The tobacco moth did not complete its life cycle at a relative humidity of less than 50 percent at temperatures between 70 and 90° F. The larval period was shorter as temperature increased, but larvae developing at 70° F. were the largest. Richmond, Va.

c. Insect resistance

Intramural--Basic research on resistance has been broadened to include studies on the susceptibility of resistant species to a larger number of insecticides, the relationship between the resistance developed for one insecticide and the susceptibility to other insecticides of the same and of other chemical groups; and on the level of resistance in the  $F_1$  and succeeding generations of genetic crosses between resistant and nonresistant strains. Resistance among stored-product insects was found more serious than first indicated. Fourteen strains of almond moths collected in various warehouses showed resistance to malathion. Red flour beetles collected in peanut warehouses were 11 to 24 times more resistant to malathion and were 13 times more resistant to pyrethrins than the laboratory strains. These data indicate that resistance developed to one insecticide may make the insects resistant to other insecticides of unrelated chemical structure. Savannah, Georgia.

d. Indian-meal moth

Extramural--Population behavior and bionomics of the Indian-meal moth in a closed environment. Clemson University.

Extramural--Determination of existence and origin of a sex attractant pheromone in the Indian-meal moth and evaluation of its physical and chemical properties. University of Georgia.

Extramural--The effect of various frequencies and intensities of sound on the behavior and physiology of the Indian-meal moth. University of Georgia.

e. Insects in vineyards and wineries

Intramural--More information was obtained on the distribution of insects attacking grapes in the vineyards and infesting wineries. This information led to the development of improved control methods. Fresno, California.



## B. FOREST SERVICE

### 1. Division: Forest Insect Research

#### APPROACH--Basic Research

##### Problems and Progress:

##### a. European pine shoot moth

Intramural--Good progress has been made in research in the recently established program to eradicate the European pine shoot moth which is threatening ponderosa pine of the Pacific Northwest. An olfactory mating response has been established. Little success has been attained in forced mating in the laboratory. The duration of moth flight and the life span of male and female moths have been determined. On the basis of these findings, it appears that, if sterilization techniques are developed, liberation of sterilized individuals will have to be made at least twice during the flight period to obtain significant effect. Corvallis, Oregon.

Extramural--Nutritional and developmental requirements of the European pine shoot moth. Washington State University.

##### b. Douglas-fir beetle

Intramural--An artificial diet has been developed for the Douglas-fir beetle that permits 75 percent development from newly-hatched larvae to 4th instar larvae. The development of an efficient, artificial diet for the beetle is a major step in studying its nutrition. It provides a reference diet with which synthetic diets and dietary constituents may be compared in the next phase in nutrition studies. This knowledge will be basic to development of biological, cultural and genetic resistance measures of preventing and controlling beetle damage. Corvallis, Oregon.

##### c. Tussock moth

Intramural--A technique was developed for rearing tussock moth which provided 10,000 larvae needed for production of virus disease for field testing. Corvallis, Oregon.

##### d. Sawflies

Intramural--A sawfly pest of white pine, apparently new to Ohio has been identified as Acantholyda luteromaculata. Its life history has been determined and a satisfactory method for sampling stages inhabiting the soil has been developed. Distribution of larvae in the soil and its relation to defoliation patterns is being studied. A paper chromatographic analysis of red and green larval color phases suggests that genetic mechanisms control the color differences. Delaware, Ohio.



e. Black locust borer

Intramural--Techniques for rearing the black locust borer have been improved. This will provide an increased supply of beetles needed in chemosterilant research. The technique employs an artificial diet consisting of a base plus vitamins, a fungus inhibitor and an anti-bacterial agent to which black locust powder has been added. It appears that 3 to 4 generations per year may be reared on the diet. Field collected material yields only one generation. Delaware, Ohio.

f. Gypsy moth

Intramural--Recent analysis of life table data of a 21-year record of gypsy moth populations in New England and a 6-year record for New York, has provided valuable information for evaluation and control of gypsy moth outbreaks. It revealed that outbreaks at low levels may be controlled by maintaining forest conditions to favor predators (especially small mammals and birds) and insect parasites or by the use of sterilized or otherwise genetically altered male gypsy moths. Heavy outbreaks may best be controlled by environmental manipulation to encourage naturally occurring viral or bacterial disease or by introducing a supplementary disease organism. New Haven, Conn.

g. Various insects and pests

Intramural--A number of exploratory studies have been started on the neurophysiology of the sensory apparatus of such insects as the southern pine beetle, the pales weevil and the Virginia pine sawfly. Such research is basic to an understanding of insect attraction which is being studied for the insect species mentioned. Research Triangle, N. C.

Extramural--Cone and seed insects--Western white pine. University of Idaho.

Extramural--Hardwood insects. University of Michigan.

Extramural--Serological investigations of Pissodes species. University of Connecticut.

Extramural--Biochemical variations in D. frontalis. University of North Carolina.





#### h. Southern pine beetle

Intramural--Valuable information is being gained on the nutritional requirements of the southern pine beetle. Chemical analysis of loblolly pine shows presence of 8 carbohydrates and 13 amino acids. The same constituents were recovered from bark of infested material as from uninfested. Qualitatively there is no apparent seasonal change in concentrations of free soluble sugars. However, fluctuations in total amino acid content do occur during the growing season, when beetle attack is most common, being lowest in September. Moisture content of inner bark is also lowest in September. Research Triangle, N. C.

Intramural--Study revealed that direct control measures against the tree-killing southern pine beetle are most effective if applied in the fall, winter and spring. Research on seasonal variation in activity of the beetle in east Texas and central Louisiana shows that number and size of outbreaks increased most rapidly during April, May and June. Alexandria, La.

#### i. Budworms

Intramural--Significant findings have been made on studies of the fecundity of the black-headed budworm. The female produces an average of 85 eggs; variation ranged from a few to 150 per female. A regression analysis showed a significant correlation between pupal size and egg production. Nonmated females produced sterile eggs. Such information will be useful in formulation of life tables and making population predictions. Data on mating habits are needed for studies to determine feasibility of control by sterilization techniques. Juneau, Alaska.

Intramural--A technique for successfully rearing the early stages of the budworm has been developed. It is now being used to mass rear large populations of budworm for studies of its biology in relation to research on attractants and chemosterilants. St. Paul, Minn.

Extramural--Population dynamics, jack pine budworm. University of Michigan.

Extramural--Flycatcher predation on spruce budworm. Colorado State University.

Extramural--Biology of pine budworm. Colorado State University.



j. Elm spanworm and fall cankerworm

Intramural--Studies reveal that the elm spanworm and fall cankerworm exhibit similar responses to population densities and resulting body color. At low population densities, larva color is light; at high densities, larvae are dark. Crowding yielded darker female spanworm pupae with fewer eggs. Evidence suggests that color variation in the two looper species is regulated by neurosecretory activity which likely affects egg production and duration of life stages. Athens, Ga.

k. Coneworm

Intramural--The artificial diet for rearing the destructive coneworm has been improved by addition of vitamins C, B<sub>1</sub>, and B<sub>6</sub> which increase larval survival by 20 percent. It has been found that survival increased and span of life decreased when the coneworm was reared in total darkness. Olustee, Fla.

l. Aphids

Extramural--Determine the stimulatory or toxic effects of substances injected into the bark by feeding aphids as evidenced by induced anatomical changes in the bark and cambial regions. Oregon State University.

m. Engelmann spruce beetle

Extramural--Engelmann spruce beetle--woodpecker study. Colorado State University.

n. Elm bark beetle

Extramural--Investigate and evaluate elm bark material responsible for host-insect relationship of elm bark beetle. Ohio State University.

o. Yellowjackets

Extramural--Ecology and control of yellowjackets on recreation areas. Ohio State University.

p. Columbian timber beetle

Extramural--Nutritional relationships of the Columbian timber beetle. Purdue University.



q. Red pine scale

Extramural--Red pine scale study. Bartlett Tree Research Laboratory.

Extramural--Red pine scale study. University of Massachusetts.

r. Bark beetle

Extramural--Correlation of climate with bark beetle outbreaks in the southeast. Clemson University.

Extramural--Mites associated with bark beetles. Louisiana State University.

s. White pine weevil

Extramural--Biology and control of the white pine weevil in the southern Appalachians. Virginia Agricultural Experiment Station.

t. Insecticides

Extramural--Systemic insecticides. Michigan State University.

2. Division: Forest Disease Research

APPROACH--Basic Research

Problems and Progress:

a. Root rot

Intramural--Poria weirii, the cause of a serious root rot of Douglas-fir, is inhibited by nitrogen in nitrate form, such as that fixed in the soil through action of the root nodules of red alder. This finding is of potential application in developing a biological means for controlling the pathogen. Study of the survival of the pathogen in soil and buried root sections is being continued. Corvallis, Oregon.

b. Mycorrhizae in root disease

Intramural--Studies of the role of mycorrhizae in root disease of western conifers reveal that mycorrhizal fungi, which mantle the rootlets, may protect them from pathogenic infection. Such protection may be through secretion of antibiotic materials, formation of a physical barrier to infection reduction of surplus carbohydrates with a lowering of appeal to the pathogens, or possibly through the buildup of protective organisms on the root zone. Corvallis, Oregon.





Intramural--In basic research to determine the organisms associated with mycorrhizae of Douglas-fir, three types of mycorrhizae, each formed with a different mycorrhizal fungus, were compared for populations of bacteria, molds and Streptomyces to evaluate extent of protection of the root flora against pathogens. The rhizosphere microorganisms differed both in kind and number and could vary markedly in beneficial effect on the associated trees. Corvallis, Oregon.

c. Wetting and stain of lumber

Intramural--Tests were completed of two wax emulsion sodium pentachlorophenate solutions commercially available for the protection of lumber against wetting and stain during storage, shipment, and building construction. At the recommended concentrations neither product afforded worthwhile protection, but they did prove to be effective at about twice the recommended concentration. Gulfport, Mississippi.

d. Fusiform rust spores

Intramural--Basic studies have shown that acetates and bicarbonates inhibit the germination of fusiform rust spores, even in the presence of otherwise stimulatory compounds. These materials may become the bases for cheap, effective, and safe protectant fungicides. Gulfport, Mississippi.

e. Brown spot needle blight

Intramural--Derivatives of the antibiotic cycloheximide have been tested for control of the brown spot needle blight on longleaf pine. A single application at 50 ppm produced significant reduction in the disease, but the residual effectiveness was of such short duration that control was not economical. Gulfport, Mississippi.

f. Dwarfmistletoe

Intramural--Prospective chemical formulations were studied to provide a safe, effective chemical control of dwarfmistletoes in western conifers. An iso octyl, ester of 2, 4, 5-trichlorophenoxybutyric acid appears promising. Elimination of root-suppressing fungi attacking Monterey pine seedlings through selective soil fumigation appears promising. Berkeley, Calif.

Intramural--The taxonomy and biology of western species of dwarfmistletoe is under study in an attempt to clarify the genus and as an aid to formulating and carrying out control procedures. Similar basic research is underway on canker and foliage diseases of alpine and subalpine tree species. Fort Collins, Colorado.



g. Peridermium filamentosum rust

Intramural--Some races of Peridermium filamentosum rust produce short aeciospore germ tubes. A single collection from Arizona produced long germ tubes. This morphological distinction will simplify and speed life cycle test of the fungus. Logan, Utah.

h. Chlorotic dwarf

Intramural--Evidence was obtained that susceptibility of eastern white pine to chlorotic dwarf is genetically controlled, and the disease apparently results from a causal agent acting directly upon the foliage rather than on the root system of the tree. Healthy trees remained resistant when grafted to infected white pines and diseased "scions" did not improve when grafted to healthy trees. Delaware, Ohio.

i. Diebacks and declines of forest trees

Intramural--Diebacks and declines of forest trees are on the increase in the Northeast. Studies of the physiological basis for this type of disease are underway and should provide clues as to the control approach to be taken in this relatively new area of disease concern. New Haven, Connecticut.

j. Fomes annosus

Extramural--Study of Fomes annosus. Pennsylvania State University.

k. Bacteria

Extramural--Investigation of bacteria associated with decay and discoloration of northern hardwoods. University of Connecticut.

l. Oak bark beetle

Extramural--Evaluation of small oak bark beetle as vector of oak wilt fungus. University of Missouri.

3. Division: Timber Management Research

APPROACH--Basic Research

Problems and Progress:

a. Animal browsing

Intramural--A minimum dosage of TMTD to deter rabbits from planted seedlings has been worked out. This chemical has been shown to repel rabbits in cage-trials, but it was not consistently



effective in operational planting. A detailed study showed that the treated seedlings had far too little of the chemical to deter the rabbits because of the method of application, quality of the adhesive, and weathering losses. Olympia, Washington.

Extramural--Protection of hardwood regeneration from deer and rabbit browsing. Mississippi State University.

Extramural--Physiological response of Douglas-fir to animal alterations. University of Washington.

b. Residual plant pesticides and fumigants

Extramural--Uptake, accumulation, and cycling of residual plant pesticides by wood plants. University of Georgia.

Extramural--Interrelationships of soil fumigants, mycorrhizae, and associated microflora of tree seedling roots. North Carolina State University.





## C. COOPERATIVE STATE RESEARCH SERVICE

### APPROACH--Basic Research

Basic research is being done on biology, taxonomy, ecology, physiology, pathology metabolism and nutrition of insects, plants and animals to develop safe means of control of plant pests and diseases and animal parasites. Insects, mites, nematodes, weeds, plant pathogenic fungi and viruses, and parasitic metozoa of domestic animals and their relationships to their hosts are being studied. Some examples of specific lines of research are: infectious processes in insects, biochemistry and mode of action of herbicides, effect of pesticides on enzymes, insect plant relationships, vectors of corn viruses, transformation of insecticides by plants, sub-lethal effects of pesticides on embryonic development of chickens, genetic and biochemical nature of disease resistance in plants, aphid population control via attractants, repellents and photoperiod, and biological activities of insecticidal derivatives.

Basic research progresses on the biology, ecology, physiology and nutrition of stored-products insects. It deals with mitestatic agents for the control of cheese and grain mites and protection of food during marketing.



III To develop less persistent conventional pesticides, improved methods of application, and detection methods of determining residues in the processing and marketing of agricultural commodities.

A. AGRICULTURAL RESEARCH SERVICE

1. Division: Animal Disease and Parasite Research

APPROACH--Control by Systemic Treatments

Problems and Progress:

a. Bovine venereal trichomoniasis

Intramural--Bovine venereal trichomoniasis, a major reproductive disease, may be curable and eradicable by simple means. A synthetic compound, dimetridazole, has shown exceptional promise as a systemic treatment. Previous treatments have been unreliable and have generally involved arduous topical applications of medicaments to the genital organs of infected bulls. Dimetridazole can be administered by capsule or admixed with feed for 5 successive days, or current research indicates that similar results may be obtained with a single intravenous injection of the drug. It is well tolerated in all respects, and potential residue hazards are minimal since bulls of breeding age comprise a relatively insignificant part of the food supply. This simple treatment, therefore, may aid considerably in salvaging valuable breeding stock and in reducing the estimated annual loss of about \$8,000,000 ascribed to the disease in the United States.

b. Roundworms and gapeworms of fowl

Intramural--Large intestinal roundworms of pigeons and gapeworms of turkeys are being removed by thiabendazole-medicated mash. Investigations demonstrated that thiabendazole administered in poultry feed removes two kinds of helminthic parasites for which there is no other satisfactory treatment. No adverse effects of the drug were observed. Beltsville, Md.

2. Division: Crops Research

APPROACH--Less Persistent Conventional Pesticides

Problems and Progress:

a. Dutch elm disease

Intramural--Progress is being made on a safe systemic fungicide to control Dutch elm disease, presently controlled by dangerous pesticide sprays applied to the foliage. Ohio



b. Pecan scab

Intramural--A new fungicide gave excellent control of pecan scab with fewer spray applications than currently used fungicides. Georgia

c. Weeds

Intramural--Studies of the analogs of the herbicide, trifluralin, resulted in discovery of an analog, benefin, which is more selective than trifluralin. Beltsville, Md.

Intramural--A new herbicide, siduron, was found to be selective for annual weed-grass control in new seedings of perennial forage grasses. Tifton, Georgia

Intramural--The problems of stand establishment in forage grasses and failure of fields to be certified due to presence of weeds, have been eliminated by several new herbicides. Oregon

Intramural--Research on the parasitic plant, witchweed, showed that the herbicide, picloram, translocates from treated sorghum to untreated, attached witchweed.

d. Johnsongrass

Intramural--Progress is being made on effective herbicides to control Johnsongrass, but complicating factors such as wide differences in susceptibility to dalapon and failure of some herbicides to translocate to rhizomes make Johnsongrass control a difficult problem. Mississippi

e. Desiccant for cotton

Intramural--Ammonium nitrate showed promise of being a highly effective and safe desiccant for cotton.

f. Growth regulators

Intramural--A growth substance, abscisin II, occurring naturally in the cotton plant has potential usefulness in crop production and harvesting operations since it regulates defoliation, inhibits plant growth, promotes plant aging, and reduces dormancy in buds.

g. Fungus

Extramural--Basic studies on the nature of fungicidal action by microwave and radio frequency absorption methods. Southwest





Research Institute

h. Virus diseases

Extramural--Investigations on the nature of virus diseases of bulb crops. Oregon Agricultural Experiment Station

APPROACH--Methods of Application

Problems and Progress:

a. Multiple pests

Intramural--Field evaluations of combined uses of pesticides for control of multiple pest problems indicate that combination treatments for control of nematodes, weeds and soil-borne disease were equal or superior to each pesticide applied separately. Tifton, Ga.

b. Nematodes in navel oranges

Intramural--Postplanting nematocide (DBCP) treatments in irrigation water increased yields of navel oranges by 37 percent in infected groves and increased premium grade fruit by as much as 77 percent. Tempe, Ariz.

c. Nematodes

Intramural--Preliminary data from basic studies indicate that certain chemicals applied to plant foliage can prevent nematodes from attacking the roots. Beltsville, Md.

d. Cotton seedling disease

Intramural--Better methods of application have resulted in widespread use of fungicides for cotton seedling disease control.

e. Weeds

Intramural--Use of spray adjuvants such as oil and specific surfactants reduced the amount of herbicides required for effective weed control. Beltsville, Md.

Intramural--Using a delayed planting technique following application of nonresidual herbicides minimized or avoided residues on the crop. Tifton, Ga.

Intramural--Applying herbicides beneath a petroleum or wax mulch increased safety and the length of herbicidal activity. New Brunswick, N. J.



Intramural--A new development in weed control in horticultural plantings offers a means of avoiding crop injury and herbicidal residues due to overdosing, by mulching with loosely woven, low-cost impregnated with pre-emergence herbicides. Beltsville, Md.

f. Growth regulators

Intramural--Spring foliage applications of the growth retardant, B-Nine, to apple, pear, and sweet cherry trees showed great promise for improving fruit production and marketing; for controlling fruit tree size; for correcting alternate bearing; and for enhancing fruit storage qualities. Wenatchee, Wash.

3. Division: Entomology Research

APPROACH--Control by Systemic Methods

Problems and Progress:

a. Cattle grubs

Intramural--Several new, highly effective systemics for the control of cattle grubs have been found and evaluated under field conditions. Some of the new materials have a very low mammalian toxicity and would be much safer to use than currently available systemics. New and more efficient means of applying them are in process of development. Corvallis, Oregon

APPROACH--Less Persistent Conventional Pesticides

Problems and Progress:

a. Mosquitoes, Houseflies and stable flies

Intramural--Research has produced new chemicals that are highly effective as residual and space sprays for control of mosquitoes, house flies, and stable flies. Several of the new materials have a very low mammalian toxicity, and would, therefore, be safer to use than currently available insecticides. Some of the new compounds are also highly specific, i.e., they are highly effective against larval or adult mosquitoes but relatively ineffective against house flies and other insects. Gainesville, Fla.

b. Mosquitoes

Intramural--Several relatively safe, highly effective new insecticides have been found for the control of mosquitoes. Corvallis, Oregon



c. Boll weevil

Intramural--Early season boll weevil control was obtained in a large field-cage test with American Cyanamid CL-47031 applied at the rate of 0.7 pound per acre to stems of cotton plants or at 10 pounds per acre as granular side dressing. The side dressing of 10 pounds gave better control than the stem application but caused some phytotoxicity. When reduced to 2 pounds it was ineffective. College Station, Texas

d. Multiple pests

Intramural--Stem treatments of cotton plants with Azodrin and UC-21149 were effective against lygus bugs, fleahoppers, spider mites, and cotton aphids in laboratory and limited field tests. College Station, Texas

Intramural--UC-21149 granular formulation applied as a side dressing was effective against boll weevil, thrips, aphids, and spider mites but was ineffective against the bollworm and cabbage looper. Florence, S. C.

APPROACH--Methods of Application

Problems and Progress:

a. Multiple pests

Intramural--In research on improved formulations of insecticides, experimental low-volume applications of undiluted technical malathion sprays deposited about twice as much insecticide on spinach and bean plants as did conventional dilute emulsion sprays at the same dosage of active ingredient and the deposits persisted more than twice as long. This more efficient deposition would permit less frequent applications. Low-volume applications of other insecticides are being investigated. Laboratory and field spraying equipment has been designed and constructed for use in these studies, to duplicate the type of spray-particles produced by aerial spraying, mist blowers, and aerosols. Beltsville, Md.

b. Mosquitoes

Intramural--Preliminary evaluation of a new spray technique (low volume application) indicates promise of more effective and economical control of mosquitoes, while reducing the hazards to beneficial insects and wildlife. Gainesville, Fla.





Extramural--Investigations on aerial dispersal methods of highly concentrated insecticides for mosquito control. State of California, Department of Public Health

c. Dog fly

Extramural--Investigations on insecticidal methods of controlling the dog fly, Stomoxys calcitrans (Linnaeus) in the Gulf Coast region of Northwestern Florida. Florida State Board of Health

4. Division: Agricultural Engineering

APPROACH--Methods of Application

Problems and Progress:

a. Verticillium wilt

Intramural--Experimental equipment was developed and used to apply soil pesticides for control of Verticillium wilt of vegetable crops. Ohio

b. Corn insects

Intramural--In cooperation with the Ohio Agricultural Experiment Station, insecticide granules were applied for control of the Northern corn root worm with equipment developed or adapted for small plot treatment. In one experiment using twelve different insecticides only one, heptachlor, was significantly better than the untreated check yielding 18 bushels of corn per acre more than the check.

Intramural--In investigations with the Iowa Agricultural Experiment Station the major emphasis of the program for insect control in corn was the screening of new insecticides, development of systemic insecticide control, and development of combined control of the European corn borer and corn rootworms. The results of these studies indicate that several experimental compounds may be as effective for borer control as presently recommended compounds. Experiments show that it is possible to combine the control of first-generation corn borers and corn rootworm larvae with one application of insecticide.

Intramural--DDT was further evaluated for its effectiveness in controlling corn earworms in sweet corn. Effective earworm control was not obtained by any of the treatments investigated. Georgia



### c. Multiple Pests

Intramural--A flying spot particle analyzer system has been installed for use in counting and sizing measurements on fine particle systems. This equipment is to be used by all of our projects where particle size is an important factor. Wooster, Ohio.

Intramural--Methods of controlling damping off in nursery plantings and control of populations of various nematode species in fruit and vegetable plantings are progressing. Ohio

Intramural--Preliminary investigations were made at five locations on the application of low-volume spray application equipment for applying technical Malathion. A nozzle and boom sprayer for treating individual rows was developed, also a special unit for use with an air-blast type row crop sprayer.

Intramural--Extensive spray application tests were made with a Bell D-1 helicopter in cooperation with Entomology Research. The effect of boom length and location, height of flight and speed of application on the shape of spray pattern and swath width, were investigated. These tests were made with a uniform nozzle arrangement; however, the variation in deposit across the swath indicate the need of additional tests with nonuniform nozzle arrangement to obtain a reasonable uniform deposit rate. Oregon

Intramural--In spray distribution tests with the TBM (torpedo bomber) airplane, in cooperation with Forest Service, a long underwing spray boom did not produce an appreciably wider swath at deposit levels generally used in forest spraying than did a shorter trailing boom. From the equipment operations standpoint the short boom on the trailing edge of the wing is to be preferred over the longer underwing boom. Maryland

Intramural--Investigations by other workers have shown that electro-static charging of dusts results in more effective deposition. The behavior of electrostatically charged spray drops was studied with respect to the atomization, distribution, and foliage coverage of the spray. A rotary type laboratory spray apparatus was devised to charge the drops in a water spray as it was atomized. A set of four spray charging devices have been designed for mounting on an airplane for further studies of the use of this type of equipment. Maryland

Extramural--Investigations designed to develop improved equipment and techniques for application of agricultural materials from low speed aircraft. Mississippi Agricultural Experiment Station



d. Weeds

Intramural--Several methods of applying pre-emergence chemicals for weed control in corn were used in investigations cooperative with the Iowa Agricultural Experiment Station. None of the pre-emergence treatments gave full season weed control, and one additional mechanical cultivation was required for band treatments.

Intramural--Early spring applications of atrazine and dimazine on plowed soil successfully controlled weeds in corn throughout the growing season without secondary tillage or cultivation. Similar applications on unplowed cornstalk ground were nearly as successful but required one mechanical cultivation. Iowa

Intramural--Field studies were made in cooperation with the Missouri Agricultural Experiment Station to evaluate different methods for directed applications of Dalapon for weed control in corn. Directed applications were made that varied from no leaf protection to maximum leaf protection provided by tying the leaves to the corn stalk. No significant corn damage was noted for any of the treatments. This was the first year (of 3 years) where no damage occurred, apparently because of absence of rainfall after application this year.

Intramural--Field studies were continued to determine the effectiveness of 8, 10, 12, 14, and 16-inch band applications sprayed over the rows, of Amiben and NAPCP for weed control in soybeans. In each case, the amount of active ingredient for the area actually covered was the same, resulting in a saving of chemical for the narrower bands. Missouri

Intramural--No significant initial field studies were made to determine the effectiveness of depth of incorporation of two herbicides used for weed control in soybeans. Incorporation of Amiben and Trifluralin to depth of 0-, 1/2- and 1-inch with a power rotary cultivator did not result in increased weed control or soybean yields. No combination of herbicide and incorporation depth resulted in any significant better weed control than when the herbicide was not incorporated. Missouri

e. Leaf spot on sugar beets

Intramural--Five series of comparative tests for Cercospora leaf spot on sugar beets were made in cooperation with the Ohio Agricultural Experiment Station, using boom and nozzle-type hydraulic sprayers. The untreated check plots were virtually defoliated in late August following a short rainy period and though these beets grew new leaves, their sugar content was





reduced. The sprayed plots decreased in disease count as the number of applications increased. The yield in gross sugar per acre was greatest with the 10-day schedule using 6 spray applications.

f. Livestock insects

Intramural--Work is centered on developing equipment and procedures that will reduce the chemical hazards associated with control of livestock insects by reducing the volume and improving the uniformity of spray applications. An automatic cattle sprayer has been developed that controls barn flies on cattle as well as conventional equipment, and with 30-40 percent less insecticide. This sprayer is activated by the cattle stepping on a switch-mat and applies a measured volume of insecticide through a system of nozzles. The application is uniformly distributed over the animal by the placement of the nozzles. This development is a significant contribution to the reduction of pesticide residues as well as to the reduction of labor and cost required in spray treatment of cattle. Kerrville, Texas

5. Division: Market Quality Research Division

APPROACH--Less Persistent Conventional Pesticides

Problems and Progress:

a. Grape insects

Intramural--The malathion-treated drying trays continued to be effective and the residues on the grapes were not influenced by type of roll or by turning the grapes on the treated tray. Dichlorvos vapor gave excellent kill of Drosophila in wineries. Fresno, Calif.

b. Moths

Intramural--The entire project was directed towards developing safe home and commercial mothproofing treatments. Several benzyl quaternary ammonium compounds, widely used as antiseptics, germicides, and sanitizers, and a number of poly-substituted nitrogen compounds having a high order of microbiocidal activity were found promising as mothproofers. Studies on formulation and application of the more effective ones were started immediately. Savannah, Georgia

Extramural--Investigations of the physical and chemical factors affecting the sorption and retention of quaternary ammonium moth proofing compounds by wool. Harris Research Laboratories



c. Multiple pests

Intramural--Improved malathion formulations were developed for protecting inshell almonds and walnuts. Fresno, Calif.

Intramural--Laboratory and small-bin tests were expanded. Several more effective experimental treatments were found. Tifton, Georgia

Intramural--Several new insecticides were found to be effective in preventing insect damage to grains. Some of the new materials were specific for certain species; others were more general in toxicity. New fumigant formulations were tested, including one material that leaves no residue on the grain. Conditions influencing the effectiveness of fumigants were studied. Manhattan, Kansas

Extramural--Design, construct, test and install an experimental fumigation chamber with controlled temperature, humidity, vacuum, and pressure features to test the effects of fumigants under controlled conditions. Vacudyne Corporation

d. Cigarette beetle

Intramural--Seventeen candidate compounds were tested against the cigarette beetle. Three were highly effective in both residual and vapor action. Another was less effective but should be investigated further because of its specificity and extremely low mammalian toxicity. None of the compounds was highly effective as an attractant or repellent. Richmond, Va.

APPROACH--Detection Methods

Problems and Progress:

a. Multiple pests

Intramural--Investigations were started on improving and shortening the time required for sample preparation, cleanup procedure, and gas chromatography procedures for detecting pesticide residues in various harvested agricultural commodities. Progress is being made in the detection of methoxychlor, DDT, lindane, and diazinon residues. Savannah, Georgia

b. Moths

Extramural--Investigations on the development of simple, rapid, methods and equipment for qualitative detection of pesticides and their metabolites in plant and animal products. Midwest Research Institute



## APPROACH--Packaging

### Problems and Progress:

#### a. Multiple pests

Intramural--A detailed study of packaging used in the dried fruit and tree nut industries is in progress. As soon as the problems are clearly identified, the results of the research in this area will be applied and investigations of improved packaging will be conducted. Fresno, California

Intramural--The activity in this project consisted of initiating two large overseas shipment tests as the final phase on the development of insect-resistant multiwall paper bags; an evaluation of the type G multiwall paper bag developed specifically for CCC to protect nonfat dry milk against insect infestation; a series of tests on the development of insect-resistant cotton bags; and a limited effort on improving the insect resistance of small unit containers. The early results of the two overseas shipment tests conclusively show that a multiwall paper bag with an insect-tight closure and the approved synergized pyrethrins treatment on the outer ply will protect flour and cornmeal against insect infestation, whereas the conventional bags used for these commodities offer little or no protection against infestation normally encountered during storage and shipment. This research shows that the Department can realize a savings of millions of dollars from the use of insect-resistant bags for the various commodities it handles. Results are promising for making bags insectproof by treating the bags and/or by using a suitable liner. Savannah, Georgia

Extramural--Development of methods for preventing insecticide migration on food packages. Battelle Memorial Institute





## B. FOREST SERVICE

### 1. Division: Forest Insect Research

#### APPROACH--Less Persistent Conventional Pesticides

##### Problems and Progress:

##### a. Douglas-fir tussock moth and spruce budworm

Intramural--Procedures have been developed for continuous mass rearing of Douglas-fir tussock moth and spruce budworm for chemical insecticide studies. Berkeley, Calif.

Intramural--Preliminary evaluations have been made of the biological activity of 53 chemicals (including 4 metabolites and 10 synergists) and 15 carrier systems against selected forest insect defoliators with emphasis on the spruce budworm. A number of the nonpersistent chemicals tested showed greater biological activity than DDT (the only chemical currently known to be effective against the pest insect tested). Field trials will be conducted this summer with three of the most promising chemicals against the spruce budworm. Berkeley, Calif.

Extramural--Zectran in connection with spruce budworm control. University of California

##### b. Multiple pests

Intramural--It has been found that DDT can be converted to DDD by reduced porphyrins. As porphyrins are present in both plant and animal systems, and as DDD is apparently more resistant to metabolism and degradation than DDT, this could account for accumulations of DDD in certain lake waters and other parts of areas treated with DDT. Berkeley, Calif.

Intramural--A system has been developed for studying the rate of penetration of test insecticide formulations through minute, isolated cuticular membranes from coniferous foliage. Penetration into the host tree substrate is desirable with certain chemicals and undesirable with others. This system will aid greatly in developing chemical carrier systems engineered for specific purposes.

Extramural--Chaparral ecosystem. University of California



c. Termites

Intramural--In field studies in which treated soil is exposed to the elements, 100 percent protection against subterranean termites has been obtained with water emulsions containing 1.0 percent chlordane for 16 years, 0.5 percent aldrin and dieldrin for 15 years, and with 0.5 percent heptachlor for 12 years. These studies are still in progress; hence, the maximum period of protection that these formulations will give is unknown. Gulfport, Miss.

Intramural--Granular formulations of aldrin, chlordane, dieldrin, and heptachlor applied on the surface of the soil (to simulate treatment prior to pouring concrete slabs) in field studies continue to give 100 percent protection against subterranean termites after about 6 1/2 years. Results after one year, however, suggest that granules are unsatisfactory for treating existing buildings because of the difficulty of getting proper distribution. Gulfport, Miss.

APPROACH--Methods of Application

Problems and Progress:

White-pine cone beetle

Intramural--Improvements in the performance of the systemic Bidrin for the control of white-pine cone beetle has been achieved largely by the use of correct methodology. Studies were made of different formulations, concentrations, dosages and schedules. The material was injected into the tree through 1/4 inch holes drilled one inch deep at specified intervals around the bole 3 feet above the ground. Treatments several weeks before cone beetle emergence did not provide protection to maturing cones. New Haven, Conn.

2. Division: Forest Disease Research

APPROACH--Methods of Application

Problems and Progress:

a. White pine blister rust

Intramural--Efforts to control white pine blister rust with antibiotics have met with questionable success. It is important that known concentrations of the spray material be maintained. Research has shown that cycloheximide is removed from the spray mixture by any water present. All equipment must be kept free of



water and tree surfaces should be dry before spraying. Tests to determine the viability of the rust in treated trees have been developed. Moscow, Idaho

b. Basidiomycetes

Intramural--Several Basidiomycetes, including both harmful and beneficial ones, have been tested for their reaction to concentrations of Phytoactin ranging from 1 to 400 ppm. At 10 ppm, which exceeds the concentration level per unit volume in treated trees, no differences from the controls (0-ppm) can be detected. Continued study will determine whether fungicidal or fungistatic effects are produced by this antibiotic in a concentration-over-time series. Moscow, Idaho

c. Root diseases

Intramural--Research to improve control of root diseases of ponderosa and pinyon pines showed that mycorrhizae were important to the health of trees in the area and that a number of fungi were involved. Microscopic examination of mycorrhizal root tips showed that portions of a fungal mantle were formed on ponderosa pine grown in culture with Hypomyces lactifluorum. Albuquerque, New Mexico

d. Dwarfmistletoe

Intramural--Study of growth rates of healthy trees and those in six dwarfmistletoe infection intensity classes showed that tree growth was reduced slightly in trees only moderately infected yet decreased rapidly with heavy infection. Mortality in the heavily infected class offsets growth of other classes thus indicating that prevention of heavy infection is the control approach most likely to reduce heavy loss. Albuquerque, N.M.

e. Fomes annosus

Intramural--Two critical factors were tested by inoculating one end of 8-inch long sections of fresh pine roots with F. annosus and other test fungi. After suitable incubation, isolations were made from the root sections. Most of the fungi tested were able to block growth of F. annosus, but Peniophora gigantea was the only fungus tested that was able to replace F. annosus. Durham, North Carolina

Intramural--The growth of Fomes annosus in roots of naturally infected Pinus taeda stumps was related to the colonization of these roots by other fungi entering through the stumps surface





F. annosus infection in roots decreased from 58 percent to 23 percent between the tenth and twelfth month following cutting. In the same period, Peniophora gigantea increased from 20 to 50 percent and apparently was important in replacing F. annosus in stumps. Durham, N. C.

Extramural--Response of loblolly pine to Fomes annosus. North Carolina State University

f. Needle blight

Extramural--Needle blight of Austrian and ponderosa pines. University of Nebraska

g. Oak wilt fungus

Intramural--In a study of effect of inoculum spore load and inoculation site on incubation period and symptom expression, black oaks were inoculated in either the bole or a lateral branch with one of six spore dosages of the oak wilt fungus. Bole inoculations were more effective in causing infection than were crown inoculations but in both cases inoculation success increased with inoculum spore load. Delaware, Ohio

h. Southern cone rust

Intramural--Southern cone rust is the most damaging disease affecting slash pine cone and seed production. Cones are susceptible to rust from emergence through pollination. Ferbam spray at 5-day intervals in this period gives protection against the rust disease. Athens, Ga.

i. Littleleaf disease

Intramural--Studies on morphology of sexual and asexual structures and comparisons of growth rates, sporangial production, and colony development on solid media, were made with isolates of mating types of Phytophthora cinnamomi. This fungus is one part of the disease complex known as the littleleaf disease of southern pines. Athens, Ga.

3. Division: Timber Management Research

APPROACH--Methods of Application

Problems and Progress:



a. Woody brush

Intramural--Herbicides are needed to kill woody brush that retards growth of natural conifer reproduction in California. Eight-year-old sugar pine reproduction within clumps of mountain white-horn increased height growth for 2 years after foliar application of herbicides. Aqueous sprays of the low-volatile esters of 2, 4, 5-T were more effective than comparable 2, 4-D treatments. The season and rate of application strongly influenced the results. Sugar pine survival and growth were good and brush kill was high when one pound acid equivalent per acre was applied in September. Silviculturists now have a cheap, effective means of releasing sugar pine reproduction.

b. Unwanted northern trees

Intramural--Managers of northern hardwood stands need to know the costs and effectiveness of applying chemicals in frills to kill unwanted northern trees. Recent studies show that a 40 percent solution of sodium arsenite in complete frills produced nearly a 100 percent kill in a 2 year period. Partial frills were nearly as effective. Next in effectiveness was a mixture of 2, 4-D and 2, 4, 5-T in oil, single or double applications of which produced about an 82 percent kill. Treatments using 2, 4, 5-T and machine girdling were the least promising. These results provide a basis for planning commercial TSI operations in northern hardwood stands. Also, in the Northeast, studies show that a mixture of Tordon 22 K and Tordon 101 has superior translocation properties over the commonly used 2, 4-D and 2, 4, 5-T. The Tordon mix is effective when as little as 1 ml. is injected at 6-inch spacings on oak. Season appears to have no effect on results. Other studies show that injections of water soluble amines of 2, 4, 5-T are twice as effective during the peak of the growing season as at other seasons of the year.

c. Seedling failures

Intramural--Many landowners in Louisiana have been reluctant to invest in hardwood control by tree injection until seedling establishment is certain. Studies show that growth of loblolly pine seedlings is substantially retarded when release is deferred for a year or more after seeding. Regardless of site or cover conditions, delay until the end of the critical first growing season results in growth reduction, and stocking may be seriously depleted. Seedling failures rarely occur on an average or better site when hardwoods are deadened promptly. The results show that hardwood control costs will be returned through increased growth and stocking. Costs of injection during the growing season were



reduced from \$4.32 to \$1.84 per acre, a savings of 57 percent. Prescriptions have been developed for the most effective dosage of lower cost 2, 4-D amine and spacing of injector incisions to kill hardwoods of different sizes and species at various times of the year. Alexandria, La.





## C. COOPERATIVE STATE RESEARCH SERVICE

### APPROACH--Less Persistent Conventional Pesticides

#### Problems and Progress:

The research deals with the biology and control of insects and mites, plant pathogenic fungi, parasites of livestock, poultry, weeds and nematodes. A number of projects are investigating means of reducing the need for the use of pesticides or increasing their effectiveness so that smaller amounts may be used or substituting less toxic pesticides. For example, research, such as that on non-toxic sprays to control leaf diseases of crops, increased efficiency in the use of fungicides, development of tillage replacing herbicide systems and alternatives to direct insecticidal control of injurious forest, nursery and greenhouse insects and mites, indicate the specific nature of some of the lines of this research.

### APPROACH--Methods of Application

#### Problems and Progress:

Pesticide application equipment in relation to drift of pesticides and pest control, interactions between insect pathogens and chemical pesticides, methods and equipment for application of agricultural pesticides, means of controlling coccidiosis in cattle, are examples of specific lines of research in this area.

### APPROACH--Detection Methods

#### Problems and Progress:

The research in this area is mainly on the detection and determination of the amount of pesticide residues and products formed from them in harvested commodities.

### APPROACH--Packaging

#### Problems and Progress:

Research is progressing on improved packaging of foods to mitigate the need for chemical control of insect pests.



IV. To determine the toxicological and pathological effects of pesticides and other agricultural chemicals in livestock; to determine the fate and effect of residues in soils, crops, and farmstead water supplies; and determine the effects of trace levels of pesticides occurring in our current food and feed supplies.

A. AGRICULTURAL RESEARCH SERVICE

1. Division: Animal Husbandry Research

APPROACH--Pesticide Effects on Livestock & Poultry

Problems and Progress:

a. Chemical residues in milk

Intramural--Research has been concerned primarily with grass and corn silage. Researchers have found that some insecticides persist under the conditions present in the silo in contrast to relatively short persistence in dry hay. They found that the treatment of corn with as much as 32 ounces per acre of dimethoate proposed no residue toxicity problems with lactating dairy cows. Thiodan applied to bermuda grass at the rate of 4, 8, and 16 ounces per acre did not result in detectable levels of residues in milk produced by cows consuming the forage. Tifton, Georgia

Intramural--The new funds have provided for the initiation of studies on the extent to which chlorinated hydrocarbons are transmitted into milk and on methods of increasing the elimination of these pesticides from the tissues. Beltsville, Md.

Extramural--Investigations to determine the factors affecting the rate of absorption and excretion of heptachlor and heptachlor-epoxide in the milk of dairy cows. Maryland Agricultural Experiment Station

b. Health of beef cattle

Intramural--Technical grade dimethoate caused a reduction in feed intake and seemed to impair the health of beef cattle. This was not true when corn was treated with pure dimethoate. Tifton, Ga.



Intramural--Ruminal microbes exposed to Diagonon and Cygon were not affected by the pesticides, nor were the pesticides apparently affected by action of the microbes. Beltsville, Md.

Intramural--The new funds provided for studies on malathion and DDT regarding the dissipation of these pesticides and their metabolites after a massive dose has been administered or during low level chronic dosing.

c. Phosphate insecticides in dairy cows

Extramural--Investigations to determine the extent to which the phosphate insecticide, GS-13005, is deposited in the body tissues and excreted in the milk of dairy cows, and its physiological reactions in the animal body. Virginia Polytechnic Institute

d. Malathion residues in poultry

Extramural--Investigations of malathion residues in poultry meat and eggs. Iowa State University

e. Insecticides and herbicides in feed

Extramural--Metabolism and fate of chemicals applied as insecticides or herbicides to forage crops that are subsequently fed to dairy or beef animals. University of Georgia

Extramural--Research on accumulation and dissipation of insecticides in beef cattle fed contaminated feeds. Virginia Agricultural Experiment Station

f. Radiocontaminants in feed

Extramural--Investigation of factors affecting the metabolism of environmental radiocontaminants that may be injected in the natural feed of livestock. Agricultural Experiment Station of Cornell University.

APPROACH--Effect of Feed Additives

Problems and Progress:

Cotton pelt condition and steatitis in mink

Intramural--The addition of feed grade Ferrous Fumarate to the diets of mink successfully prevented the cotton pelt condition and was beneficial to production. The addition of 112 grams of





BHT per ton gave ample protection from steatitis of mink but half that amount failed to prevent heavy losses when the mink were fed unprotected high fish diets. Petersburg, Alaska

2. Division: Animal Disease & Parasite Research

APPROACH--Pesticide Effects on Livestock and Poultry

Problems and Progress:

a. Herbicides and pesticides in feed

Intramural--Studies are being made to determine the chronic toxicological effects of ingestion of herbicides (atrazine and monuron) in sheep. This investigation has been carried out by feeding two groups of ewes on each of the respective herbicides. The atrazine groups were fed 15 and 30 mg/Kg of body weight and the monuron groups were fed 30 and 75 mg/Kg of body weight from the day of breeding until 30 days after lambing. This experiment is still in progress and will continue for approximately another 30 days until all animals have lambed. All ewes on the high level of atrazine died approximately six weeks after the start of the experiment and the animals on the low level of atrazine have continued to lose weight and become extremely weak while the animals fed monuron have not shown such extensive toxicity.

Extramural--Research studies on the preparation and characterization of various forms of barium antimony tartrate to determine the degree of toxicity and residues in edible products of various preparations of this compound which are used as a tool in the control of parasitic and infectious diseases connected with poultry management. Stephen F. Austin State College

b. Pesticide dosage exposure levels

Extramural--Research to study the toxicological effects of pesticides on livestock to determine acceptability for use and safe dosage exposure levels. Texas Agricultural Experiment Station

c. Uniform particle size of pesticides

Extramural--Research studies of the necessary materials, used with a particle size spectrometer, for the solution of the problem of maintaining uniform particle size emulsion droplets. Stephen F. Austin State College



### 3. Division: Crops Research

#### APPROACH--Fate and Effect of Pesticide Residues in Soils

##### Problems and Progress:

##### a. Weed seed in soil

Intramural--Investigations to discover herbicides and methods of preplanting application that will destroy weed seed before crops are planted and not leave a residue, have shown great differences in the persistence of various herbicides when applied at various depths in the soil. Beltsville, Md.

Extramural--Basic studies on the effects of chemical stimulants and inhibitors on weed seed germination, seedling growth and sensitivity of weedy plants to freezing and drought.  
University of Wisconsin

##### b. Soil micro-organisms

Intramural--Studies on the effect of pesticides on beneficial soil micro-organisms, the particular chemical structure of an herbicide was found to be related to microbial degradation; for example, compounds having a chlorine in the beta position were more resistant to degradation than those having one in the alpha position. Beltsville, Md.

Intramural--The effect of soil micro-organisms on the degradation of pesticides using the herbicide, dalapon, has revealed it to be degraded rapidly, leaving no hazardous residues. Soil bacteria of the genus *Arthrobacter* convert dalapon to pyruvic acid, a universal compound in living organisms.

Extramural--Basic research on the influence of herbicides on soil microorganisms with special reference to interactions with phytopathogenic fungi. Auburn University

##### c. Loss of soil surface-applied volatile herbicides

Intramural--In other experiments conducted in specially built air velocity chambers, the rate of loss of soil surface-applied volatile herbicides was shown to be greatly accelerated by air velocity of only 4 m.p.h., emphasizing the importance of herbicide application when air movement is minimal and the use of soil incorporation techniques in preventing loss of vapors, thus reducing effectiveness and safety. Beltsville, Md.



d. Herbicides for cotton

Intramural--Research to find nonresidual herbicides for cotton which will not injure following crops of vegetables is progressing. Weslaco, Texas.

APPROACH--Effect of Pesticide Residues on Crops

Problems and Progress:

a. Determination of sites of action

Extramural--Basic studies on the nature and significance of an in vivo study of cytological effects of selected herbicides as a basis for determining sites of action. Dartmouth College.

b. Structural changes in plants

Extramural--Basic studies on the nature and significance of structural changes induced by selected herbicides in particular plant species. University of California.

c. Johnsongrass control

Extramural--Investigations designed to develop new principles and improved practices for the control of Johnsongrass in soybeans under conditions typical of the Middle Mississippi Valley area. University of Missouri.

APPROACH--Multiple Effects of Residues

Problems and Progress:

Interactions of various pesticides

Extramural--Investigations designed to determine the presence and effect of interactions between major classes of herbicides, insecticides, fungicides, and nematocides applied to selected plant species. North Carolina Agricultural Experiment Station.

APPROACH--Effect of Pesticide Residues in Food Products

Problems and Progress:

Herbicides in food crops

Extramural--Investigations to determine the effects of selected herbicides on composition and quality of food crops. Ohio Agricultural Experiment Station.





4. Division: Entomology Research

APPROACH--Multiple Effects of Residues

Problems and Progress:

Japanese beetle control

Extramural--Determine the effects of residues from area treatments for Japanese beetle control in Michigan on crops, animal products, water resources, fish and wildlife, beneficial and pest insects and other arthropods. Michigan Agricultural Experiment Station.

5. Division: Agricultural Engineering Research

APPROACH--Effect of Pesticide Residues in Soil

Problems and Progress:

Vegetable crops

Intramural--Soil treatments were applied to vegetable crops in muck soil to determine the effects of residues remaining in the soil. Ohio

APPROACH--Fate and Effect of Pesticide Residues in Water Supplies

Problems and Progress:

a. Preventing pesticides in farmstead water supplies

Intramural--The objectives of this project are to assemble information on the use and handling of pesticides on and around the farmstead and to develop methods for preventing entry of pesticide pollutants into farmstead water supply systems. Beltsville, Md.; Watkinsville, Ga.

b. Determination of pesticide pollution of water supplies

Intramural--A cooperative sampling and analysis program has been developed with the Maryland State Department of Health. The Health Department is concerned with pesticide pollution of public streams and water supplies. Beltsville, Md.

6. Division: Market Quality Research

APPROACH--Effect of Pesticide Residues on Crops

Problems and Progress:

Tobacco

Intramural--Dichlorvos was applied daily as an aerosol at 0.5 gram per 1,000 cubic feet for 5.5. months in a tobacco warehouse.



Tobacco samples taken from a location of heavy exposure contained only trace amounts of dichlorvos. Richmond, Va.

#### APPROACH--Effect of Pesticide Residues in Food Products

Problems and Progress:

##### Vitamin content in grain

Intramural--Cooperative studies were started to determine the effects of fumigant residues on vitamin content of grain and grain products. Manhattan, Kansas.

#### 7. Division: Human Nutrition Research

#### APPROACH--Effect of Pesticide Residues in Food Products

Problems and Progress:

##### a. Food composition

Intramural--Effects of fumigation of stored wheat on vitamin content of grain, milling fractions, and home-baked products; and on baking performance of flour for household use. Beltsville, Md.

Intramural--Nutrient composition of eggs and quality of the meat from hens treated with malathion. Beltsville, Md.

Intramural--Nutrients of peanuts as affected by lindane treatment of soil. Beltsville, Md.

Extramural--Investigations of the effects of malathion on the nutrient composition of eggs and the eating quality of poultry meat. Food and Drug Research Laboratories.

##### b. Physiological and metabolic response

Intramural--The metabolic response of the rat to diets containing high levels of bromide residues. Beltsville, Md.

Intramural--The physiological response of rats to diets which include different kinds of fat with and without added chlorinated hydrocarbon pesticides. Beltsville, Md.

Intramural--The metabolic effects of pesticide residues in body fat when the content and distribution of body fat of rats fed different diets are altered by dietary restrictions. Beltsville, Md.



Extramural--Investigations to determine the physiological response of rats to diets which include different kinds of fats with and without added chlorinated hydrocarbon pesticides. Swift & Company

c. Food Quality

Intramural--The effect of preparation and cooking on the pesticide residue content of selected vegetables. Beltsville, Md.

Intramural--The eating quality of foods and food products as affected by use of pesticides and other agricultural chemicals in food production. Beltsville, Md.

Extramural--Investigations on the effect of preparation and cooking on the pesticide residue content of selected vegetables. National Canners Association Research Foundation

8. Division: Soil and Water Conservation Research

APPROACH--Fate and Effect of Pesticide Residues in Soils

Problems and Progress:

a. Pesticide reactions

Intramural--Studies are being conducted to determine the extent to which insecticides and their transformation products are adsorbed or react with soil organic constituents. Fort Collins, Colo.

Intramural--Research is going forward on the movement and decomposition of chlorinated pesticides in soils. Fort Collins, Colo.

b. Determination and identification

Intramural--Work is in progress on the development of analytical chemical methods required for the identification and determination of chlorinated pesticides and their degradation products in the soil. Recovery studies of heptachlor, aldrin, dieldrin, and endrin from soils have ranged from 73 to 91 percent. Work is continuing toward improved recoveries. Beltsville, Md.





c. Transitional elements

Intramural--Studies are being conducted on the agricultural significance of certain transitional elements derived from pesticides and other agricultural chemicals. Work is in progress on the development of analytical chemical methods for determining heavy metal residue accumulations in soils. Both emission and absorption spectrochemical procedures are being evaluated. Recoveries of Hg, Pb, Ni, Cr, Co, V, Cu, Zn, and Cd from standard solutions ranged from 70 to 100 percent and from extracts of soil samples from 10 to 100 percent. Studies on improved extracting techniques are continuing. Beltsville, Md.

d. Microbial processes

Intramural--Studies are being conducted on the effects of pesticides and other chemical contaminants on microbial processes in soils. Beltsville, Md.

APPROACH--Fate and Effect of Pesticide Residues in Water Supplies

Problems and Progress:

Runoff

Intramural--Studies were initiated on the loss of pesticide materials in runoff from agricultural lands following their application on farm crops. Preliminary results of these studies indicate that losses of certain chemicals in washoff are related to its chemical composition, the time interval before rainfall occurs after application, and soil moisture at time of application. These studies are being continued and expanded. Watkinsville, Ga.



## B. FOREST SERVICE

### 1. Division: Forest Soil and Water Research

#### APPROACH--Fate and Effect of Pesticide Residues in Soils

##### Problems and Progress:

##### Rate and Nature of movement

Intramural--Using a continuous data logging tension lysimeter system, with supplemental environmental and soil measurements, the project is studying the rate and nature of the movement of insecticides, their location and persistence in a forest soil, their biological and chemical effects on the forest ecosystem, and the effect of the ecosystem on the decomposition of insecticides. Residues from light applications of DDT, such as are commonly used in forests, are being studied for the first time, particularly that deposited in the soil from litterfall and precipitation passing through the tree canopy. Changes in numbers of soil bacteria, fungi, and streptomycetes, after forest spraying will be related to amount of DDT in the soil. Also a series of integrated studies will probe how pesticide chemicals are held in and on a wide range of benchmark soils to provide leads for recommending improvement in chemical application practices. Due to the short life of this project, reportable results are not yet available.

Extramural--Study the rate and nature of movement in the soil of surface applied insecticides. University of Washington



## C. COOPERATIVE STATE RESEARCH SERVICE

### APPROACH--Pesticide Effects on Livestock and Poultry

#### Problems and Progress:

The research centers around the physiological effects of pesticides on livestock, Deposition of pesticides and their metabolic products in poultry, livestock, and wildlife; physiological consequences of long term exposure to low levels of pesticides; relationship of insecticide ingestion, animal metabolism and external contamination to residues in milk and milk products, effect of insecticides on reproductive efficiency of Coturnix quail and similar specific lines of research are in progress.

### APPROACH--Fate and Effect of Pesticide Residues in soils, crops and water

#### Problems and Progress:

The movement, behavior, distribution, accumulation, deposition, persistence, detoxification and disposition of pesticides in soils receives strong emphasis in this area. The effect of pesticides on the quality of water and on aquatic organism also receives strong emphasis. The effects of pesticides in soils on forests, blueberries, potatoes, cranberries and other crops are being studied. The monitoring and assay of phytotoxic airborne pesticides and volatile pollutants, interactions between pesticides and soil microorganisms, mechanisms and extent of adsorption of pesticides by soil particles and colloidal components of soils, are being investigated.

### APPROACH--Effects of Pesticide Residues in Food Products

#### Problems and Progress:

About two-thirds of the research in this area is in the three regional research projects, Trace Levels of Pesticide Residues in Agricultural Commodities in Marketing Channels; Chemical and Nonchemical Measures for Market Channel Pest Protection; and Reduction or Elimination in Commercial Channels of Adverse Effects of Pesticide Residues of Food and Feed Products. The titles of these projects indicate the nature of the research being pursued. Also, research is in progress on the effects of food processing and storage on insecticide residues, accelerated removal of insecticide residues from domestic animals to be used for food, effects of pesticide residues in milk on micro-organisms important in the dairy industry, and pesticide residues in milk and their removal.





V. To determine the comparative costs of the various methods of controlling insects and the economic effects of restrictions on the use of toxic chemicals in agricultural production.

A. ECONOMIC RESEARCH SERVICE

1. Division: Farm Production Economics

APPROACH--Survey of Pesticide Use in Agricultural Production

Progress:

Intramural--Arrangements were made with the Survey Operation's Group, Statistical Reporting Service, to carry out the field work necessary for the conduct of this survey on a reimbursement basis. Farms were selected on a probability sample basis to be contacted by personal interview. The field enumeration for the survey was carried out during March and April 1965. Information on farm characteristics, crop and livestock production, pesticide use and pest control practices was obtained. A total of 11,700 completed questionnaires were obtained from farms distributed throughout 47 states (Hawaii and Alaska were not included in the survey and the probability sample did not result in any farms being drawn in Rhode Island). The information obtained is now in the process of being prepared for Automatic Data Processing prior to tabulation and summarization.

APPROACH--Analysis of Farm Costs and Returns for Alternative Pest Control Methods

Progress:

Intramural--There was no work completed on this phase of the research during Fiscal Year 1965. However, arrangements have been made for work to be started at Nebraska and Michigan during FY 1966.

APPROACH--Aggregate Economic Implications of Pest Control in Agricultural Production

Progress:

Intramural--The work on the appraisal of aggregate implications of changes in pesticide use has been limited to a brief review of alternative approaches to the analysis and a preliminary investigation of the joint relationships in the use of agricultural resources. The purpose of this trial investigation is to explain how additional units of selected factors contribute to production. The factors that are associated with farm production in the analysis are land, labor and capital inputs--



pesticides, fertilizer, and lime; machinery; purchased feed, seed, and livestock; and other capital inputs.

## 2. Division: Resource Development Economics

### APPROACH--Economic Appraisal of Damaging Pesticide Residues Relative to the Use of Water

#### Progress:

Intramural--A mail inquiry was completed covering major water pollution control agencies and experiment stations in each of the 48 contiguous states. The inquiry was designed to reveal the extent and immediate causes and effects of farm related water pollution due to pesticides. The inquiry also covered fertilizers, animal wastes, and stream turbidity and sedimentation. Response was 67 percent with one or more reports received from 43 states. The results have been analyzed and a draft report completed. This report also details economic research needs and suggested priorities.



## B. COOPERATIVE STATE RESEARCH SERVICE

### APPROACH--Practices, Costs, and Methods Used in Controlling Plant and Animal Pests, and the Use of Chemicals

#### Progress:

Research on the economics of the use of pesticides is the main area of research. Some specific lines of this research are as follows: role of dealers in informing consumers about characteristics and uses of pesticides, pesticide sales and consumption, methods and practices of purchasing and utilizing agricultural pesticides, chemical weed control in field crops as related to cultural and management practices and cost of production, marketing of chemical pesticides, the incidence and nature of consumer reactions to the use of pesticides in producing food products, economic effect of controlling tobacco insects by means of light traps, cultural control and insecticides on the market value of tobacco and the communications configuration among rural residents on controversial aspects of pesticide use.





## VI. Educate the public concerning the safe and proper use of pesticides

### FEDERAL EXTENSION SERVICE

#### APPROACH--Chemical Information Centers

##### Progress:

Intramural--All States have established a Central Chemicals Information Center in one or more locations within the State. These centers are under the direction of the chemical leaders or coordinators who are responsible for maintaining current files of Federal and State laws, regulations and research which relate to all aspects of the safe and proper use of pesticides and residue tolerances. The chemical coordinators are also responsible for the overall leadership of the pesticide-chemical program, keeping members of the State Extension Services staffs abreast of changes, new developments, and problems. Maintenance of liaison and cooperation with key personnel in other disciplines, agencies and organizations on problems of mutual concern is also a prime function. Typical of the groups with whom liaison and cooperation is effected are the following: State Departments of Agriculture, Public Health, Fish and Game, Recreation and Wildlife, Water Resources and other Statewide organizations or groups such as pesticide applicators, dealers and farm organizations.

#### APPROACH--Committees

##### Progress:

Intramural--An important aspect of Extension's expanded chemicals education program has been the encouragement and development of advisory committees. As of June 30, 1965 there were more than 300 extension, university, State and county advisory committees whose functions are to serve as advisory and planning bodies for educational programs concerned with the safe and proper handling, storage and use of all categories of pesticides.

#### APPROACH--Extension Service Review

##### Progress:

Intramural--The April 1965 Extension Service Review was devoted to the safe and proper use of pesticides including the varied types of educational activities that are being carried on in the States. This publication was distributed to all State and county extension workers, members of the various USDA pesticide



committees, and committees and individuals outside the Department of Agriculture in industry, and other governmental agencies which included the Food and Drug Administration and Public Health Service of HEW, and the Fish and Wildlife Service of the Department of Interior.

#### APPROACH--Training Activities

##### Progress:

Intramural--An increased number of in-depth training schools and short courses have been held in all States for audiences such as extension agents, vocational agricultural teachers, producers, dealers, suppliers, medical doctors, fieldmen, or custom aerial and ground applicators. These have ranged from one to several days duration depending on the interest, problems and needs of the various audiences involved. Our estimates place the number of in-depth and general training schools, where training on Safe and Proper Use of Pesticides-Chemicals is included, as 300 and 3,000 respectively.

#### APPROACH--Liaison

##### Progress:

Intramural--At the national level Extension has maintained liaison and cooperated with organizations and groups such as the National Agricultural Chemicals Association, National Safety Council, National Cotton Council, National Cannery Association, Manufacturing Chemists Association, National Wildlife Federation, and the National Pest Control Association in planning and counseling with them on programs concerned with pesticide use. Another phase of the expanded liaison and cooperative effort has been the role which extension has played in serving in an advisory capacity on various committees within the Department of Agriculture. In this capacity we have related and passed on information on problems and situations in the field to the staff members of other agencies.

#### APPROACH--Distribution of Materials

##### Progress:

Intramural--Timely distribution of materials on pesticide laws, regulations and residue tolerances on feed, forage, fiber and food crops has been an important part of extension's educational effort. To briefly summarize the impact and scope of this effort, the office of the FES Chemical Leader has distributed over 125,000 pieces of literature relating to pesticide chemicals to



their State counterparts this year. This does not include bulk orders for the States.

#### APPROACH--Poison Control Information Centers

##### Progress:

Intramural--State Extension Service personnel have also taken the lead in counseling with the staff members of Poison Control Centers and in calling the attention of their various audiences to the location of the Center nearest to them. This liaison and close working relationships has helped minimize deaths due to accidental poisonings.

#### APPROACH--Publications

##### Progress:

Federal Extension Service has also been instrumental in getting States to modify their publications through encouraging them to use such titles as, "Suggested Pest Control Guide," instead of, "Pest Control Recommendations." Inclusion of more statements on safety precautions in handling, storage and use of pesticides are now becoming commonplace in State publications. As a matter of fact, several States have made it mandatory to include safety precautions in every publication mentioning pesticides.





VII. Establish and maintain a Pesticides Information Center to support research on pesticide projects

NATIONAL AGRICULTURAL LIBRARY

APPROACH--Computer-based system

Progress:

Intramural--The Pesticides Information Center began regular publication of its biweekly indexing journal--Pesticides Documentation Bulletin--in March 1965. This is a computer-produced index covering worldwide literature on pests and their control, including diseases, insects, nematodes, parasites, weeds, and other pests affecting plants, animals, and man. Included also is literature on the biological, toxicological, physiological, biochemical, pathological, biophysical, and epidemiological aspects of pests and their control by chemical and nonchemical methods. It is expected that the final computer based system for Pesticides Information Center will serve as a prototype for additional documentation centers in other subject areas.

Extramural--A contract to design and program a computer-based information storage, retrieval, and publication system. Datatrol Corporation.



VIII To coordinate the pesticide research, education and control efforts of the U.S. Department of Agriculture with the efforts of other Federal Agencies and with State and Municipal organizations.

#### INTERDEPARTMENTAL COORDINATION

##### APPROACH--Information Dissemination

###### Program and Progress:

Public information programs on the safe and effective use of pesticides including publications, radio and TV programs have been developed to create a better public understanding of the programs on pests and their control conducted by the Departments of Interior, Health, Education, and Welfare, and Agriculture and the cooperating States.

A series of films on pests and their control for use by all Federal departments in creating a better public understanding of pests and pesticide problems is being developed. A full-length color film is designed for use in improving public understanding while a series of short films are being developed on specialized subjects for specialized audiences.

Support is being given the preparation and publication of seven manuals on the principles of pest control. These basic manuals will include information on all major classes of agricultural pests and will be available to scientists in the participating departments as well as to State and private organizations. These manuals are being developed through a contract with the National Academy of Sciences and National Research Council.

##### APPROACH--Symposia and Conferences

###### Program and Progress:

A multidiscipline, interagency national symposium on the science and art of pest control is being developed under contract with the National Academy of Sciences and National Research Council. Scientists, administrators, and educators from State, Federal and private organizations will participate in the symposium in an effort to improve communications, cooperation and coordination of programs on pests and their control.

An interagency research work conference was sponsored, in cooperation with the Department of Interior and Health, Education,



and Welfare. Scientists from Federal and State agencies reviewed current research programs and plans for future programs. They evaluated significant findings from current programs and opportunities for interagency cooperation.

Sponsored a conference of State pesticide information specialists to develop a national pesticide information program to increase public understanding of pest control, pesticides, and pesticide problems, including specialized information programs for specialized audiences in the regions and States.

#### APPROACH--Studies and Reviews

##### Program and Progress:

An in-depth study of the relationships between agricultural developments and practices and the production and protection of wildlife and the conservation of natural resources is being conducted. This study will help to separate facts from unsupported theories as to the beneficial and detrimental effects related to the use of pesticides and other agricultural practices. The study is being developed under contract with the National Academy of Sciences and National Research Council.

Support the review and evaluation of pesticide research programs within the Department of Agriculture, and to obtain in-depth information on pesticide research programs conducted by other Federal departments, the States, and private organizations.









